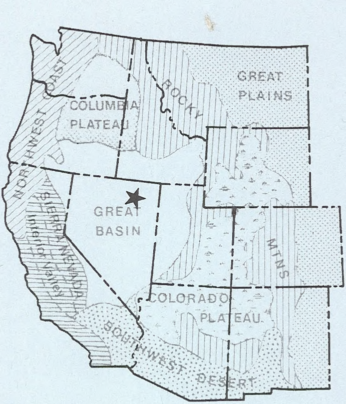
Saval Ranch Research and Evaluation Project



PROGRESS REPORT 1986

July 1987

PROGRESS REPORT FOR 1986

SAVAL RANCH RESEARCH AND EVALUATION PROJECT

Editor

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Unpublished and Preliminary Information

July 1987

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INTRODUCTION

The Saval Ranch Research and Evaluation Project was initiated in May, 1978. The overall objective was to evaluate the effects of livestock grazing management systems and range improvement practices on livestock production, vegetation, fish and wildlife and their habitat, watershed hydrology, water quality, economic factors, and other resource values.

Funding and support have been provided by the Bureau of Land Management, U.S. Forest Service, Agricultural Research Service, and Agricultural Experiment Station, University of Nevada, Reno.

The Project has been directed by an Executive Committee comprised of representatives of the supporting agencies and cooperators. On September 9, 1986, the Executive Committee agreed to phase out the project. Field work will cease as of September 30, 1987.

Although the original objectives of the project, as stated above, were never achieved, a vast amount of information regarding this northeast Nevada rangeland has been gathered and many scientific publications are resulting from the work.

Summaries and interpretations of data and information on locating data sets in computer files have appeared in a series of annual reports. In 1982 and 1983 annual progress reports were produced in a spiral bound volume format. In 1984, 1985, and 1986 annual progress reports were bound and produced as BLM, Nevada State Office, Technical Reports. All the above reports have been distributed to numerous BLM, USDI, and USFS libraries as well as to government document depository libraries. Prior to 1982 progress reports were unbound and issued separately for individual disciplines. The final report for the project will appear in 1988.

Generally, the common names of plants and animals are used in this report. Scientific names are given in an Appendix appearing in previous years' annual reports.

The scientific results and conclusions reported here are to be considered unpublished and preliminary in nature. They are presented to meet contractual agreements and to provide the supporting agencies and parties with a basis for judging progress. No results should be cited or quoted without permission from the authors.

ACKNOWLEDGEMENTS

Once again Saval Project investigators received excellent assistance provided by Student Conservation Association volunteers. The 1986 volunteers, provided through an agreement between the Association and the Bureau of Land Management, were Cindy Toering and William Watson. Abbie Garsky helped as a summer employee and Gary Acordagoitia assisted in many ways as project technician.

PUBLICATIONS BASED IN PART

OR IN FULL ON SAVAL RANCH PROJECT

Armentrout, D.J. and M.R. Barrington. 1980. A multiple resource inventory for multiple use land management decisions. CAL-NEVA Wildl. Trans. 1980:92-99.

Armstrong, R.M., C.R. Blincoe, C.F. Speth and D.R. Hanks. 1981. A comparison of lignin, acid insoluble ash and beryllium as internal ruminant digestion indicators. Proc., Western Section, Am. Soc. Animal Sci., 32:218-219.

Back, G.N., M.R. Barrington and J.K. McAdoo. 1987 (in press). Sage grouse use of snow burrows in northeastern Nevada. The Wilson Bull., 99(3):.

Bohn, C. (In Review) Comparison of hydrometer settling times.

Johnson, C.W.; M.R. Savabi, and S.A. Loomis. 1984. Rangeland erosion measurements for the USLE. Trans. Amer. Soc. Agric. Eng., 27:1313-1320.

Loomis, S.A. 1983. SPUR applications and limitations - Management. Pp. 111-116. In J.R. Wight (Ed.) Spur - Simulation of Production and Utilization of Rangelands: A Rangeland Model for Research and Management. U.S. Dept. Agr. Misc. Publ. 1431.

McAdoo, J.K. and D.A. Klebenow. 1979. Native faunal relationships in sagebrush ecosystems, p. 50-61. In Proc. of the Sagebrush Ecosystem Symposium. Utah State Univ., Logan, Utah.

McAdoo, J.K., G.N. Back, M.R. Barrington and D.A. Klebenow. 1987. Wildlife use of lowland meadows in the Great Basin. Trans. 51st North American Wildlife and Natural Resources Conf., 310-319.

Morrell, T.E. and D. Klebenow. Submitted. The influence of cattle grazing on mule deer diets in an aspen community of northeastern Nevada. J. Range Manage.

Morrow, J.L. and D.E. Brown. Submitted. Environmental factors influencing the grazing behavior of range cattle on a northeastern Nevada ranch. J. Range Manage.

Platts, W.S., K.A. Gebhardt and W.L. Jackson. 1985. The effects of large storm events on Basin-Range riparian stream habitats. Pp. 30-34 In: Proc. N. Amer. Symp. Riparian Ecosystems and their Management. Univ. Arizona, Tucson. USFS Gen. Tech. Rept. RM-120.

Platts, W.S. and R.L. Nelson. 1983. Population fluctuations and genetic differentiation in the Humboldt cutthroat trout of Gance Creek, Nevada. CAL-Neva Wildlife Transactions, 1983:15-19.

Platts, W.S. and R.L. Nelson. 1985. Streamside and upland vegetation use by cattle. Rangelands, 7:5-7.

Poole, S.C., V.R. Bohman, L.A. Rhodes, and R. Torell. 1986. The selenium status of range cattle in northeastern and central Nevada. Proc., Western Sect., Amer. Soc. Animal Science, 37.

Ports, M. and J.K. McAdoo. 1987. _Sorex merriami_: (Insectivora: Soricidae) in eastern Nevada. Southwest Natur., 31:415-416.

Ports, M. and J.K. McAdoo. Submitted. Microhabitat characteristics and overlap of three sympatric shrew species. J. Mamm.

Torell, L.A. 1987. Economic value of crested wheatgrass: A case study. _In_ Proc. Crested Wheatgrass Symp. Utah State Univ.

Torell, L.A., E.B. Godfrey and D.B. Nielsen. 1986. Forage utilization cost differentials in a ranch operation: a case study. J. Range Manage., 39:34-39.

Torell, L.A., E.B. Godfrey and R.E. Eckert Jr. 1985. Optimal livestock production on the Saval Ranch under season-long grazing and under the approved deferred/rest rotation grazing system. Univ. Nevada. Agric. Exp. Stat. Bull. TB5-85-1. 79p.

Tueller, P., P. Lent, R. Stager, E. Jacobson. Submitted. Comparison of conventional plant frequency data and color-infrared large scale aerial photography for monitoring Great Basin vegetation types. J. Photogram. Eng. & Remote Sensing.

PROFESSIONAL PRESENTATIONS

Bohn, C. and K.A. Gebhardt. Mechanisms of streambank failure on rangeland streams. Paper presented at SRM Annual Meeting, Boise ID. Feb. 8-13, 1987.

Eckert, R.E., Jr. (Ed). 1986. Saval Range Project - An interdisciplinary evaluation of intensive cattle grazing management. U.S. Dept. of Aric., Agric. Res. Serv. ARS-47. 20 p.

Eckert, R.E., Jr. and F.L. Emmerich. Evaluation of some factors influencing secondary succession. Paper presented at the SRM Annual Meeting, Boise, ID. Feb. 8-13, 1987.

Eckert, R.E., Jr., F.F. Peterson, and F.L. Emmerich. A study of factors influencing secondary succession in the sagebrush (*Artemisia* spp. L.) type. Paper presented at the Seed and Seedbed Symposium, Tucson, AZ. Apr. 21-23, 1987. Proceedings to be published.

Morrell, T.E. and D.A. Klebenow. The influence of cattle grazing on mule deer diets and nutrition in an aspen community. Paper presented at the SRM Annual Meeting, Boise, ID. Feb. 8-13, 1987.

CHAPTER 1

CLIMATOLOGIC STUDIES

Karl Gebhardt and Carolyn Bohn

1986 Objectives

Close down and dismantle a number of climate stations in preparation for FY88 project shut down.

Cooperate with ongoing Reynolds Creek Climate Data effort and continue storage of Saval climate data.

1986 Accomplishments

Stations 6 - 11 were shut down in October of 1986. Stations 1 - 5 still remain in operation (see Figure 1.1). Station 2 will be operated by the Elko District, BLM, in FY88 and there is a possibility that the U.S. Forest Service will take over operation of two of the remaining climate stations.

Data availability

Precipitation, temperature, solar radiation, and wind data are available on 5 1/4-inch floppy diskettes. The data can also be obtained in the correct format to run various hydrologic and range models. For more information contact:

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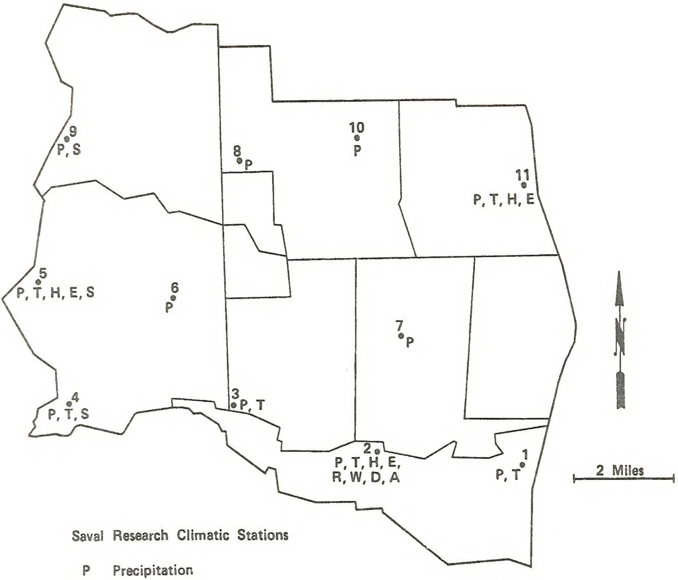
270 S. Orchard
Boise, Idaho 83705
(208) 334-1363

Climate Data

Early in 1986 the CLIMDAT (Climate Data) project began as a part of the Reynolds Creek Research and Development project and Saval Project out of the need to utilize climate records. Several states have supplied input into the early development of this project. The purpose of the project is to develop a computer climate data processing system to be used at the District or Area level. The system, called CLIMDAT, would have several functions: making available NOAA-Weather Service station data available; processing District data; processing other data; repairing and extrapolating data; performing statistical analysis; formatting data sets for use with various models; and providing simulated weather data representative of a particular location.

CLIMDAT was developed originally to supply correctly formatted climate data files to various existing range, hydrology, and soil models. There are currently over ten models available on personal computers that can estimate many range management situations such as water yield, flooding, plant growth, plant competition, livestock growth, fate of pesticides, leachate production from sanitary landfills, drought analysis, monitoring information, and



Saval Research Climatic Stations

P Precipitation
T Temperature
H Relative Humidity
E Evaporation
R Solar Radiation
W Wind Speed and Direction
D Dew Point Temperature
S Snow Course
A Atmospheric Deposition

Fig. 1.1

others. All of these models require climate data in one form or another. It became apparent, after working with the models, that users unfamiliar with programming would have a difficult time using the models because of the difficulty in producing a suitable climate data file.

After discussions with the Denver Service Center, Division of Resource Systems, Boise Interagency Fire Center, and several other District offices in Wyoming, Montana, Idaho, and Nevada, it was clear that not only was there a need for NOAA-Weather Service climate data formatting, but there was also a need to incorporate the District's climate data. Later, during the initial development of CLIMDAT, the Utah State Office became involved because of a Washington Office assignment on Climate Data Needs. The CLIMDAT project appeared to fit many of the needs addressed so long as there was no conflict with ongoing climate data acquisition systems.

Main-frame climate data acquisition systems have been in existence for quite a while. In Idaho, for example, the BLM has been using the Hydrologic Information Storage and Retrieval System (HISARS) (Molnau, 1983) since about 1980. While the system provides good access to NOAA-Weather Service stations, it does rely on main-frame communications that can be expensive and frustrating to a novice user. After examining the pros and cons of a personal computer (PC)-based system versus main-frame, it was decided for the convenience and special needs not met by the main-frame, a PC-based system would be good.

Soon after the initial start of CLIMDAT's programming, a new PC computer-based climate storage system was released by the National Climate Data Center (1987) called CLICOM. It is a very complete climate data management facility. As a part of the CLIMDAT development project, a copy of CLICOM was purchased to examine its possible use as a replacement for the functions CLIMDAT was to serve. After examining CLICOM it was determined that, while being a very complete system, it was too large of program (requiring nearly a dedicated 80-87 PC) and provided too many unusable options (from BLM's standpoint) to be a successful District management tool. However, it would be a very useful tool to use in the State Offices as a part of climate data support with the National Climate Data Center and State Climatologists.

With the above background, the basic development criteria of the CLIMDAT system are presented below.

CLIMDAT should run on any PC using the Microsoft Disk Operating System (MS-DOS) having at least 360 kilobytes of memory.

CLIMDAT should not be dependent on any commercial database software.

CLIMDAT should be able to transfer data files to and from commercial databases such as DBASE3+, RBASE5000, DATAEASE, LOTUS, ASPEN.

CLIMDAT should be transportable to mainframe computers with minor changes.

CLIMDAT should be compatible with data archived from the CLICOM system, HISARS system (or mainframe equivalent), and from the RAWS system (Remote Area Weather Station).

CLIMDAT's main menu choices are:

Enter a new station

Enter data

Repair or extrapolate

Statistics and reports

Weather Generator

Model Data Format

List of Stations

A description of CLIMDAT's main menu follows:

Enter a new station - allows the user to define up to 99 climate stations.

Enter data - allows the user to input climate data manually or automatically through file transfer.

Repair or extrapolate - allows user to fill in incomplete climate records using state-of-the-art estimation techniques or to extrapolate data sets to an area where no station exists.

Statistics and reports - allows user to prepare simple reports and graphs and to perform simple statistics on a station or group of stations.

Weather Generator - Uses a well-known computer model that simulates precipitation, temperature, solar radiation, and wind for any point in the United States (lower 48).

Model Data Format - Automatically builds an appropriate climate data file for an assortment of predictive models useful in land management.

List of Stations - Lists the stations on the system, by location, by name, number, or total.

The Saval Project climate data is supplying much of the information needed to test the functionality of the CLIMDAT system.

CLIMDAT is about 65 - 70 percent complete and a demonstration version should be available at the end of August. For more information contact:

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208-334-1892

References

Molnau, Myron, 1983. Climate and Hydrology Data for Idaho. University of Idaho, Department of Agricultural Engineering, Moscow, Idaho, 116 p.

National Oceanic and Atmospheric Administration, 1986. World Climate Data Program, CLICOM PROJECT, U.S. CLICOM SYSTEM, Data Management Module, System Overview, Products Overview. National Climate Data Center, Asheville, N.C., 31 p.

CHAPTER 2

HYDROLOGY

Carolyn Bohn

An effort has been made to document, evaluate, and summarize the various sets of hydrologic data that have been collected since the start of the Saval Project. Copies of the unsummarized data will be left with the Elko District Office and are also available as noted below. For reference, the 1981-1985 grazing schedule appears in the 1986 Progress Report, Chapter 3.

A. Unsummarized Hydrology Data and Notes

1. Daily Suspended Sediment Averages from Manning Samplers: Discontinuous records from 1982-1985 for Lower Gance and Lower Mahala Creeks. When data for comparisons exists, the Manning samples did not compare favorably with DH-48 integrated samples, and sampling error within the Manning samples is suspected. However, this is not a firm indictment, only a suggestion, and the data may prove useful if pursued.

2. Discharge, Suspended Sediment and Chemistry Grab Samples: Scattered data exist from stations between those included in this report.

3. Small Watershed Discharge Records: Daily average flow records (discontinuous) on file in Boise, (See Karl Gebhardt, BLM).

4. Water Temperature: Data from Gance Creek on file with Bill Platts (USFS, Boise).

5. Bedload: A small grab sample data set from Gance Creek Study Area during snowmelt of 1985.

Annual Hydrograph and Water Production, Gance Creek and Mahala Creek, 1982-1985

Drainage Areas: - Gance Creek = 12,307 acres at highway
Mahala Creek = 14,449 acres at highway

As they cross Mountain City Highway, both creeks display typical snowmelt-controlled annual hydrographs (Table 2.1). Peak flows generally occur in May, but smaller runoff events may begin as early as March and continue into June. Some data gaps exist due to ice in the stilling wells. It is also suspected that instream ice conditions such as ice jams and build-up may have also affected the stage records for both streams. Although peak flows and total water production varied year to year, each year the flow was similar in both streams. The data are insufficient to calculate recurrence intervals, but 1984 was commonly accepted as a "flood year" and 1985 was a low flow year. Peak flows between 50 and 100 CFS are expected, as are low flows of less than one CFS mid-summer.

Table 2.1. Total Water Production, Gance and Mahala Creeks

	Lower Gance (Ac-ft/mo)	Lower Mahala (Ac-ft/mo)
WY 1982		
Oct.	nd	nd
Nov.	nd	nd
Dec.	nd	nd
Jan.	0*	0*
Feb.	0*	0*
Mar.	765.213	320.771
Apr.	1519.396	601.463
May	1773.490	1324.293
Jun.	617.958	279.015
Jul.	239.010	1.214
Aug.	2.495	5.877
Sep.	13.131	17.363
	4930.692	2549.997
WY 1983		
Oct.	41.530	5.101
Nov.	23.778	4.136
Dec.	0*	0*
Jan.	0*	0*
Feb.	34.112	0*
Mar.	1133.047	929.946
Apr.	1683.123	1968.098
May	3289.547	2378.748
Jun.	1916.929	1184.661
Jul.	151.858	44.071
Aug.	18.889	0.00
Sep.	14.497	0.00
	8307.310	6514.761
WY 1984		
Oct.	60.972	0.00
Nov.	128.888	0.00
Dec.	579.800	0.00
Jan.	772.236	4390.171
Feb.	512.122	2152.210
Mar.	574.203	927.129
Apr.	2161.590	2230.071
May	5193.101	7193.992
Jun.	2771.981	1766.129
Jul.	487.583	250.463
Aug.	6.159	41.538
Sep.	13.537	1.539
	13262.172	18953.242
WY 1985		
Oct.	62.791	79.012
Nov.	24.345	161.111
Dec.	165.901	14.590
Jan.	51.328	0*
Feb.	14.100	0*
Mar.	399.881	86.557
Apr.	1137.098	518.552
May	545.661	419.716
Jun.	11.443	89.516
Jul.	0.00	0.00
Aug.	0.00	0.00
Sep.	0.00	0.00
	2412.548	1369.054

*Stilling well frozen?

Interestingly, although Mahala Creek tends to peak a little higher and flow a little flashier than Gance Creek, water production in acre-feet appears to be somewhat lower in Mahala Creek. However, missing data prohibit any conclusive observations.

Upstream, at the U.S.G.S. gaging stations, runoff patterns in both drainages are very similar, although Gance Creek carried a much greater volume at its station than did Mahala Creek at its point of gaging.

Variation in Suspended Sediment Samples

Two or three suspended sediment samples were often collected at a time and averaged for the working suspended sediment concentration. Analysis of multiple samples collected along Gance Creek displayed widely varying coefficients of variation (cv) in all years (1979-1982) and at all stations. The cvs were tested for relationships with patterns of discharge and suspended sediment via linear regressions. No correlations were uncovered and it is assumed that the variations among multiple samples are due to sampling error.

Results of Regressions on Stations Tested:

1. All Gance Creek Stations, 1979-1983

X vs CV (140 data points)		Q vs CV (114 data points)	
y intercept	= 24.7543	y intercept	= 25.0182
slope	= -0.0147	slope	= -0.4434
R^2	= 0.0255	R^2	= 0.0459

2. Gance Cr. @ Road Canyon #14, 1979-1982

X vs CV		Q vs CV	
y intercept	= 21.41	y intercept	= 26.7633
slope	= -0.0057	slope	= -1.3763
R^2	= 0.0151	R^2	= 0.0890

3. Gance Cr. @ Warm Cr. #10, 1979-1982

X vs CV		Q vs CV	
y intercept	= 27.7372	y intercept	= 14.3620
slope	= -0.0199	slope	= -0.3320
R^2	= 0.0647	R^2	= 0.0551

Notes on Spatial Distribution of Flow: Gance Creek and Mahala Creek

Gance Creek:

The tributaries, Road Canyon Creek and Warm Creek, were gaged as they entered Gance Creek (Tables 2.2 and 2.3). Both entered the upper headwaters of Gance Creek. While Warm Creek contributed a reasonably steady percentage of the flow in Gance Creek (20-40%), from year to year and throughout the runoff season, Road Canyon's contribution appeared more erratic from year to year and throughout the runoff season. The percentage of flow in Gance Creek that was contributed by Road Canyon was somewhat higher than for Warm Creek, but Road

Table 2.2. Discharge in CFS - Warm Creek at Gance Creek

	1979	1980	1981	1982	1983	1985
5 March		1.74	No Data - Drought Year, immeasurable flow			
24 April						3.23
26 April	3.17					
3 May				18.10		
8 May						4.02
9 May	3.78					
10 May				8.09		
14 May		3.59				
15 May	5.87					3.16
20 May		4.28				3.63
25 May				7.54		
27 May					20.79	
28 May	4.75					
29 May						2.46
2 June				4.39		
4 June						1.66
5 June		7.59				
7 June					11.07	
10 June	1.56					1.71
13 June					6.27	
14 June				1.16		
19 June		1.97				
29 June				1.35		
3 July		1.38				
24 July						0.83
30 July				0.89		
12 August				0.73		
30 Sept.		0.91				

Table 2.3. Discharge in CFS - Road Canyon at Gance Creek

	1979	1980	1981	1982	1983	1985
5 March		1.03	No Data - Drought Year, immeasurable flow			
24 April						3.01
26 April	3.69					
3 May				21.43		
8 May						3.24
9 May	4.56					
10 May				11.27		
14 May		6.44				
15 May	9.09					N.D.
20 May		8.38				2.03
25 May				16.15		
27 May					34.56	
28 May	12.26					
29 May						1.56
2 June				8.98		
4 June						N.D.
5 June		7.34				
7 June					19.53	
10 June	4.13					N.D.
13 June					11.50	
14 June				1.62		
19 June		2.21				
29 June				3.32		
3 July		0.81				
24 July						N.D.
30 July				0.85		
12 August				0.40		
30 Sept.		0.40				

Canyon is located farther upstream where the volume in Gance Creek is smaller. The actual amount of flow in any case was fairly small, ranging between 1 and 20CFS, but usually less than 6CFS.

Mahala Creek:

Jim Creek was gaged as it entered Mahala Creek in 1979 and 1980 only. The tributary appears to contribute a high percentage of flow at this point on Mahala Creek, but a small volume of water (Table 2.4).

Summary of Suspended Sediment Data

Sediment data on file consists primarily of grab sample data from varying time intervals for most drainages (Table 2.5). Also available but not summarized here, are daily Manning samples for Lower Gance Creek and Lower Mahala Creek (possible errors within). Grab sample discharge measures and sediment concentrations for selected stations on Mahala Creek and Gance Creek in 1979 and 1980 generally show sediment responding to flow, but with some anomalies (Figures 2.1-2.4). Interestingly, the sediment concentrations graphed suggest an increase downstream through the headwaters, but a dramatic decrease by the time the waters of both creeks reach the highway--perhaps due to a lessening gradient on the rangelands. Similar types of data for other years and stations are available but not graphed.

Also included here are graphs depicting the contribution by tributaries to suspended sediment in Gance Creek During spring melt-off, when most of the sediment-loading occurs, the contribution from tributaries appears in rapid peaks which usually are not sustained. Although the percentage of sediment contributed by the tributaries may seem high at times, the concentrations were usually not great. The source of the sediment is not known, but stream-banks were suspected. Generally, the percentage of sediment and flow into Gance Creek was greater from Road Canyon than from Warm Creek, which is not surprising since Road Canyon enters Gance Creek higher in the watershed where the flow in Gance Creek is still very small.

Sheep Creek Sediment Data

Grab samples of suspended sediment were collected in conjunction with discharge measurements as Sheep Creek entered and exited the Lower Sheep pasture (Stations #28 above and #27 below). Records span 1979-1984, thereby providing measurements before and after the 1981 plowing and seeding. Time series analysis of the data failed to show a notable affect on suspended sediment loadings from the seeding treatment. Yearly sediment rating curves at both stations were erratic, and an attempt to break out the data by rising and falling limbs on the Mahala Creek and Gance Creek hydrographs was likewise unproductive. Sediment loadings may have lessened post-treatment, but the data are too limited to be conclusive.

Notes on Water Chemistry

There are two sources of water quality data: (1) U.S.G.S. data from stream stations on Gance Creek and Mahala Creek (Tables 2.6. and 2.7.) (some data listed in Nevada Water Resources and more complete notes from U.S.G.S. field office in Elko), and (2) Saval project samples which were analyzed commercially (Tables 2.8 - 2.10). Although no attempt has been made to

Table 2.4. Discharge in CFS - Jim Creek at Mahala Creek

	1979	1980
3 March		0.70
2 April		0.144
4 April	0.599	
7 April		1.178
11 April	1.944	
17 April		3.000
19 April	4.016	
23 April		5.770
29 April	4.391	
30 April		10.645
7 May		13.61
10 May	5.144	
17 May	10.255	
21 May		5.779
25 May	12.343	
2 June		7.061
13 June	1.680	
16 June	5.121	
19 June	1.492	
26 June	0.176	
30 June		0.531
30 Sept.		0.015

Table 2.5. Sediment Production - Upper Gance Creek

Date	Gance Cr at Warm Cr Q	Sed(Mg/l)	Sed (g/s)	Warm Cr at Gance Cr Q	Sed (Mg/l)	Sed (g/s)	Gance Cr at Road Can. Q	Sed(Mg/l)	Sed (g/s)	Road Can. at Gance Cr Q	Sed (Mg/l)	Sed (g/s)
4/26/79	8.77	92	22.8	3.74	152	16.1	3.97	126	14.2	4.62	50	6.5
5/04/79	12.28	160	55.6	6.89	215	42.0	5.86	412	68.4	11.57	143	46.9
5/09/79	11.30	53	17.0	3.78	1	0.1	3.69	62	6.5	4.56	22	2.8
5/15/79	16.04	399	181.2	5.87	588	97.7	6.58	1553	289.4	10.39	884	260.1
5/28/79	20.05	259	147.1	4.75	21	2.8	4.67	213	28.2	12.26	140	48.6
6/10/79	6.21	14	2.5	1.56	17	0.8	1.32	15	0.6	4.13	15	1.8
6/14/79	6.43	19	3.5	1.40	20	0.8	1.21	11	0.4	5.87	14	2.1
6/19/79	5.62	23	3.7	1.65	33	1.5	1.77	20	1.0	3.21	162	14.7
6/28/79	3.22	13	1.2	0.84	12	0.3	0.77	16	0.3	2.12	14	0.8
5/14/80	9.94	22	6.2	3.59	24	2.4	3.03	32	2.7	6.44	22	4.0
5/20/80	12.61	20	7.1	4.28	10	1.2	3.81	10	1.1	10.11	70	20.0
6/05/80	21.81	120	74.1	7.59	89	19.1	12.61	68	24.3	7.48	132	28.0
6/19/80	10.24	13	3.8	1.97	23	1.3	4.73	24	3.2	2.21	6	0.4
7/03/80	4.45	2	0.3	1.38	1	0.04	2.74	4	0.3	0.81	6	0.1
5/03/82	----	---	----	----	---	----	17.95	858	451.6	21.43	763	479.4
5/10/82	----	---	----	----	---	----	7.06	38	78.7	11.27	50	16.5
5/20/82	17.33	32	16.3	8.00	19	4.5	6.00	18	3.2	10.29	26	7.8
5/15/82	22.27	181	118.2	7.54	66	14.6	6.11	61	10.9	16.15	134	63.5
6/02/82	12.00	37	13.0	4.39	16	2.1	3.40	7	0.7	8.98	49	12.9
6/14/82	3.20	0.5	0.05	1.16	5	0.2	0.30	1	0.01	1.62	1	0.05
6/28/82	6.38	36	6.7	1.35	3	0.1	----	----	----	----	----	----
7/30/82	1.52	4	0.2	0.89	7	0.2	0.10	0.5	0.001	0.85	0.5	0.1
8/12/82	0.92	----	-----	0.72	4	0.1						
8/26/82	0.76	11	0.2	1.01	12	0.4						
9/09/82	1.01	5	0.1	0.95	12	0.3						
10/07/82	1.56	21	1.0	1.10	14	0.5						
10/21/82	1.66	4	0.2	1.05	17	0.5						
11/22/82	1.80	50	2.6	0.94	68	1.9						

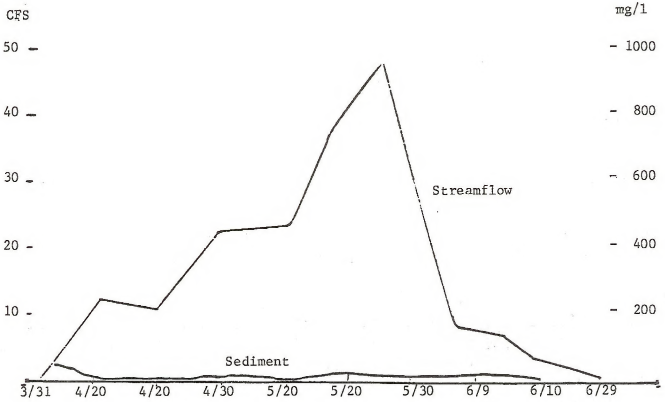

Figure 2.1. Suspended sediment (mg/1) and flow (cfs) - Lower Mahala Creek, 1979

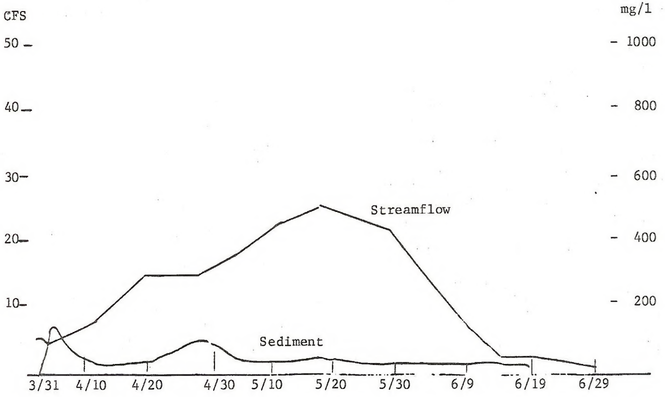

Figure 2.2. Suspended sediment (mg/1) and flow (cfs) - Lower Gance Creek, 1979

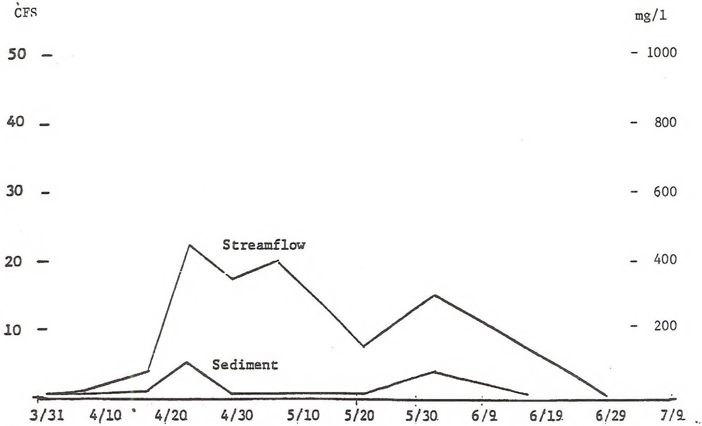

Figure 2.3. Suspended sediment (mg/l) and flow (cfs) - Lower Mahala Creek, 1980

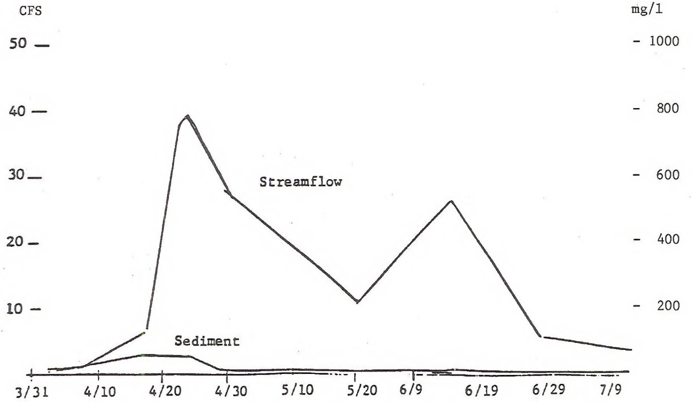

Figure 2.4. Suspended sediment (mg/l) and flow (cfs) - Lower Gance Creek, 1980

Table 2.6. U.S.G.S. Water Quality Data for Upper Gance Creek #10317460

Date	Q	Spec.	pH	D.O.	% Sat.
4/22/80	31.3	206	8.2	9.2	95%
5/06/80	24.8	209	8.1	9.4	106
6/06/80	27.2	245	7.8	9.6	99
7/08/80	4.56	337	ND	7.1	
9/04/80	1.83	367	7.8	7.9	96
10/31/80	2.26	ND	8.4	8.9	97
11/20/80	2.37	ND	8.0	10.0	98
1/20/81	2.36	ND	8.2	10.8	108
3/10/81	2.70	ND	8.6	9.3	99
4/10/81	3.69	ND	8.6	9.2	100
5/12/81	4.36	ND	8.4	8.3	98
6/08/81	2.76	ND	8.4	7.7	97
7/15/81	1.42	ND	8.4	7.1	97
10/01/81	1.46	372	8.5	8.3	95
11/03/81	1.75	391	8.3	8.8	99
12/22/81	5.68	384	8.5	11.1	104
03/25/82	6.05	313	ND	10.2	
05/20/82	21.4	243	8.2	9.1	
07/22/82	2.26	345	7.8	7.1	97
10/14/82	2.03	388	8.3	8.4	
11/04/82	2.65	386	8.8	9.3	
01/13/83	2.63	366	7.9	10.0	
02/16/83	2.69	327	ND	9.7	100
05/04/83	28.6	250	8.3	9.0	
06/07/83	40.5	241	8.1	8.7	100
07/27/83	3.59	338	8.4	ND	
10/04/83	3.27	388	8.3	ND	
12/08/83	3.72	361	8.2	ND	
02/21/84	3.83	ND	8.3	10.0	100
04/12/84	7.32	ND	8.0	9.8	101
05/17/84	53.4	ND	8.0	10.6	107
07/19/84	8.87	ND	8.3	7.8	100
10/30/84	3.82	390	8.4	9.8	
12/06/84	3.73	380	8.3	11.4	106
01/18/84	3.29	365	8.5	12.6	125
03/22/85	6.01	300	ND	10.4	109
04/17/85	21.5	195	7.2	9.7	105
05/30/85	8.04	ND	8.1	8.3	103
06/28/85	2.81	325	8.3	8.1	103
07/31/85	2.02	370	8.5	7.6	103
08/29/85	1.69	380	8.5	7.8	103

Table 2.7. U.S.G.S. Water Quality Data for Upper Mahala Creek #10317420

Date	Q.	Spec.	pH	D.O.	% Sat.	Date
4/22/80	11.2	310	7.7	9.2		
5/06/80	10.2	317	8.0	8.9	103	
6/06/80	7.52	381	8.0	7.5	95	06/09/80
7/08/80	0.80	465	7.8	7.1		07/09/80
9/04/80	No Flow					
10/31/80	No Flow					
11/20/80	No Flow					
1/20/81	No Flow					01/13
3/10/81	No Flow					
4/10/81	0.10	ND	8.2	9.4	108	
5/12/81	0.67	ND	8.1	9.0	110	
6/08/81	0.12	ND	8.8	9.8	132	06/18
7/15/81	No Flow					
10/01/81	No Flow					
11/03/81	No Flow					
12/22/81	No Flow					
03/25/82	3.04	493	ND	11.0		
05/20/82	14.8	331	8.4	8.3		
07/22/82	0.41	416	7.7	8.2	101	
10/14/82	No Flow					
11/04/82	ND					
01/13/83	0.25					
02/16/83	ND					
05/04/83	ND					
06/07/83	19.3	215	8.2	8.5	100	
07/27/83	0.54	422	8.1	7.4	87	
10/04/83	ND flow too low to collect					
12/08/83	0.16	515	7.8	12.9	139	
02/21/84	1.21	ND	7.8	10.0	100	
04/12/84	4.25	ND	8.0	9.0	97	
05/17/84	41.9	ND	8.0	10.0	108	05/16
07/19/84	1.74	ND	8.2	8.3	100	07/08
10/30/84	No Flow					
12/06/84	No Flow					
01/18/84	No Flow					01/17

Table 2.8. Water Chemistry - Gance Creek Drainage

Parameter: pH

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	8.27	ND	8.04	8.28	ND	8.10	8.31	ND
Gance at Warm Cr.	7.94	8.33	8.03	8.23	8.34	8.30	8.30	8.34
Warm Cr. at Gance	8.15	7.49	8.18	8.34	8.43	8.20	8.33	8.38
Gance at Road Canyon	7.95	8.32	7.73	8.34	8.36	8.20	8.24	8.21
Road Canyon at Gance	8.10	ND	8.03	8.23	8.35	8.30	8.13	8.27
Gance Below Black Beauty Mine	ND	8.13	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	7.33	ND	ND	ND	ND	ND	ND

Parameter: Turbidity

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	ND	ND	5.2	0.6	ND	1.8	2.0	ND
Gance at Warm Cr.	ND	ND	16.0	1.2	0.4	1.8	4.0	0.5
Warm Cr. at Gance	ND	ND	10.0	0.9	0.1	1.6	3.0	0.41
Gance at Road Canyon	ND	ND	22.0	2.1	0.1	6.5	5.0	0.4
Road Canyon at Gance	ND	ND	4.4	1.4	0.5	1.1	3.0	1.3
Gance Below Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND

Parameter: Elec. Conductivity

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	358	ND	394	440	ND	425	400	ND
Gance at Warm Cr.	222	363	237	260	360	345	231	388
Warm Cr. at Gance	228	345	242	291	329	317	258	344
Gance at Road Canyon	212	385	216	270	428	312	234	456
Road Canyon at Gance	215	ND	242	238	372	345	221	407
Gance Below Black Beauty Mine	ND	405	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	780	ND	ND	ND	ND	ND	ND

Parameter: OPO_4-P

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	.08	ND	.08	.11	ND	.07	.11	ND
Gance at Warm Cr.	.04	.07	.05	.04	.08	.05	.04	.07
Warm Cr. at Gance	.03	.02	.04	.03	.03	.03	.03	.03
Gance at Road Canyon	.03	.04	.04	.03	.06	.04	.04	.07
Road Canyon at Gance	.04	ND	.05	.02	.06	.05	.04	.05
Gance Below Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND

Table 2.8. Cont.

Parameter: Tot. P

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	.09	ND	.10	.11	ND	.08	.12	ND
Gance at Warm Cr.	.29	.09	.16	.04	.09	.07	.08	.07
Warm Cr. at Gance	.13	.03	.08	.03	.07	.04	.05	.04
Gance at Road Canyon	.03	.04	.04	.03	.08	.07	.08	.07
Road Canyon at Gance	.16	ND	.10	.03	.09	.06	.07	.06
Gance Below Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND

Parameter: NH_4-N

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	.01	ND	.01	.02	ND	ND	ND	ND
Gance at Warm Cr.	.01	.03	.01	.02	.02	ND	ND	ND
Warm Cr. at Gance	.01	.01	.01	.02	.02	ND	ND	ND
Gance at Road Canyon	.01	.01	.01	.02	.02	ND	ND	ND
Road Canyon at Gance	.01	ND	.02	.02	.02	ND	ND	ND
Gance Below Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine								

Parameter: NO_3-N

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	.03	ND	.02	.02	ND	.02	.02	ND
Gance at Warm Cr.	.88	.04	.65	.14	.10	.10	.26	.10
Warm Cr. at Gance	.46	.06	.37	.04	.10	.14	.13	.10
Gance at Road Canyon	.94	.06	.70	.10	.12	.27	.16	.10
Road Canyon at Gance	.99	ND	.68	.04	.04	.20	.42	.10
Gance Below Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND

Parameter: TKN

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	.25	ND	.20	.22	ND	.20	.22	ND
Gance at Warm Cr.	1.04	.08	.60	.26	.13	.10	.23	.13
Warm Cr. at Gance	.51	.09	.50	.16	.05	.10	.18	.12
Gance at Road Canyon	1.42	.11	.90	.28	.21	.30	.20	.20
Road Canyon at Gance	.69	ND	.50	.33	.15	.20	.20	.20
Gance Below Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	ND	ND	ND	ND	ND	ND	ND

Table 2.8. Cont.

Parameter: HCO_3

Site	Date: 5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	208.0	ND	226.6	273.8	ND	235.0	240.0	ND
Gance at Warm Cr.	115.0	209.0	118.5	147.5	215.0	176.0	125.0	214.0
Warm Cr. at Gance	128.4	196.0	139.0	176.0	192.0	180.0	146.0	188.0
Gance at Road Canyon	93.0	228.0	90.4	140.0	213.0	131.0	119.0	212.0
Road Canyon at Gance	125.0	ND	136.8	138.7	232.0	191.0	126.0	248.0
Gance Below Black Beauty Mine	ND	251.0	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	87.5	ND	ND	ND	ND	ND	ND

Parameter: Cl

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	4.4	ND	5.0	3.5	ND	5.8	4.13	
Gance at Warm Cr.	1.8	2.3	2.0	1.2	1.0	2.5	1.53	2.4
Warm Cr. at Gance	3.2	7.5	2.0	1.7	.75	1.5	1.65	1.7
Gance at Road Canyon	6.0	1.5	2.0	1.4	1.8	3.0	1.88	4.8
Road Canyon at Gance	1.6	ND	2.5	1.1	.75	2.0	1.31	2.4
Gance Below Black Beauty Mine	ND	2.3	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	2.8	ND	ND	ND	ND	ND	ND

Parameter: SO_4

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	24.0	ND	23.0	16.6	ND	31.0	20.6	ND
Gance at Warm Cr.	17.0	30.0	22.0	20.7	25.6	41.0	14.6	25.0
Warm Cr. at Gance	12.1	20.5	14.0	17.0	19.8	22.0	13.3	20.0
Gance at Road Canyon	25.0	25.0	30.0	34.8	63.0	47.0	20.6	53.0
Road Canyon at Gance	11.0	ND	14.3	12.7	22.4	28.0	10.6	22.0
Gance Below Black Beauty Mine	ND	23.0	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	332.0	ND	ND	ND	ND	ND	ND

Parameter: Na

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	7.9	ND	9.0	9.62	ND	8.8	8.48	ND
Gance at Warm Cr.	3.2	3.02	3.85	3.00	3.40	4.50	3.18	4.02
Warm Cr. at Gance	3.0	2.7	3.25	3.05	2.90	3.50	3.04	2.80
Gance at Road Canyon	3.6	3.22	4.75	4.10	7.60	6.20	4.59	9.00
Road Canyon at Gance	2.4	ND	3.0	2.38	3.4	3.8	2.31	3.6
Gance Below Black Beauty Mine	ND	4.02	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	3.7	ND	ND	ND	ND	ND	ND

Table 2.8. Cont.

Parameter: K

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	2.22	ND	2.25	2.45	ND	2.0	2.45	ND
Gance at Warm Cr.	1.07	1.77	1.24	.80	1.68	1.20	.88	1.69
Warm Cr. at Gance	.78	.90	.79	.70	.90	.80	.69	.92
Gance at Road Canyon	1.24	.90	1.63	1.00	2.05	1.3	1.07	2.42
Road Canyon at Gance	.79	ND	.95	.65	1.05	.80	.66	1.08
Gance Below Black Beauty Mine	ND	1.90	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	1.90	ND	ND	ND	ND	ND	ND

Parameter: Ca

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	41.5	ND	44.5	53.0	ND	46.0	45.0	ND
Gance at Warm Cr.	25.5	41.4	26.0	30.7	44.4	37.0	25.0	45.6
Warm Cr. at Gance	26.0	38.1	27.0	34.0	42.4	34.0	28.2	38.1
Gance at Road Canyon	23.5	46.4	22.0	31.5	49.8	30.5	24.5	50.4
Road Canyon at Gance	25.8	ND	28.0	29.0	47.0	38.5	24.5	49.3
Gance Below Black Beauty Mine	ND	46.5	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	99.7	ND	ND	ND	ND	ND	ND

Parameter: Mg

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	19.5	ND	21.6	24.2	ND	23.0	21.8	ND
Gance at Warm Cr.	11.9	22.4	12.9	14.4	21.9	19.9	12.6	23.2
Warm Cr. at Gance	13.0	20.5	12.7	17.1	20.5	18.5	14.8	20.8
Gance at Road Canyon	11.2	22.9	11.3	15.4	24.9	16.8	12.5	25.0
Road Canyon at Gance	11.6	ND	13.2	13.1	22.4	19.7	12.0	24.0
Gance Below Black Beauty Mine	ND	25.6	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	42.0	ND	ND	ND	ND	ND	ND

Parameter: SiO_2

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Gance at Highway	16.0	ND	20.3	19.5	ND	19.0	21.0	ND
Gance at Warm Cr.	10.0	20.2	13.1	11.0	17.6	15.0	11.0	15.0
Warm Cr. at Gance	8.0	10.4	10.4	9.7	10.5	11.0	10.0	9.0
Gance at Road Canyon	11.0	10.9	14.3	9.2	17.0	14.0	13.0	16.0
Road Canyon at Gance	8.0	ND	10.0	9.0	11.6	10.0	9.0	10.0
Gance Below Black Beauty Mine	ND	15.1	ND	ND	ND	ND	ND	ND
Gance Above Black Beauty Mine	ND	12.7	ND	ND	ND	ND	ND	ND

Table 2.9 Water Chemistry - Mahala Creek Drainage

Parameter: pH

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	8.50	ND	8.24	8.44	ND	8.40	8.38	ND
Mahala at Jim Cr.	8.19	ND	7.76	7.73	ND	8.00	7.85	7.99
Jim Cr. at Mahala	7.89	ND	7.79	7.86	ND	7.80	7.96	7.61
Jim Cr. at Foothill Road	7.87	ND	7.99	8.06	ND	8.00	8.00	ND
Mahala at Foothill Road	8.12	8.42	8.18	8.38	8.52	8.20	8.35	8.44
S. Fork Mahala	8.19	ND	8.17	8.54	8.01	8.40	8.30	8.39
N. Fork Mahala	8.34	ND	8.32	8.73	8.47	8.40	8.36	8.33

Parameter: Turbidity

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	ND	ND	2.3	0.5	ND	0.5	3.0	ND
Mahala at Jim Cr.	ND	ND	2.6	1.8	ND	2.0	2.0	3.9
Jim Cr. at Mahala	ND	ND	20.0	2.6	ND	8.3	9.0	ND
Jim Cr. at Foothill Road	ND	ND	17.0	3.3	ND	0.4	7.0	ND
Mahala at Foothill Road	ND	ND	37.0	0.5	0.9	4.0	3.0	1.2
S. Fork Mahala	ND	ND	6.2	0.4	0.2	1.2	3.0	1.2
N. Fork Mahala	ND	ND	16.0	0.5	20.1	0.2	3.0	0.5

Parameter: Elec. Conductivity

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	368	ND	444	618	ND	580	325	ND
Mahala at Jim Cr.	352	ND	466	485	ND	450	497	489
Jim Cr. at Mahala	144	ND	158	174	ND	226	152	276
Jim Cr. at Foothill Road	130	ND	145	160	ND	230	139	ND
Mahala at Foothill Road	342	490	361	407	449	462	375	467
S. Fork Mahala	291	ND	322	448	616	453	316	563
N. Fork Mahala	378	ND	377	320	455	567	408	684

Parameter: OPO_4-P

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	.03	ND	.04	.08	ND	.07	.07	ND
Mahala at Jim Cr.	.06	ND	.09	.08	ND	.06	.09	.06
Jim Cr. at Mahala	.05	ND	.06	.08	ND	.06	.06	.05
Jim Cr. at Foothill Road	.05	ND	.06	.08	ND	.06	.06	ND
Mahala at Foothill Road	.05	.05	.04	.03	.06	.02	.04	.04
S. Fork Mahala	.05	ND	.05	.01	.03	.04	.04	.06
N. Fork Mahala	.02	ND	.03	.03	.06	.02	.01	.02

Table 2.9. Cont.

Parameter: Tot. P

Site	Date: 5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	.05	ND	.05	.08	ND	.09	.10	ND
Mahala at Jim Cr.	.65	ND	.11	.08	ND	.06	.09	.06
Jim Cr. at Mahala	.15	ND	.13	.08	ND	.11	.12	.13
Jim Cr. at Foothill Road	.12	ND	.12	.08	ND	.09	.10	ND
Mahala at Foothill Road	.36	.09	.37	.03	.10	.12	.09	.06
S. Fork Mahala	.10	ND	.08	.01	.06	.09	.06	.06
N. Fork Mahala	.08	ND	.12	.03	.09	.02	.04	.03

Parameter: NH_4-N

Site	Date: 5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	.01	ND	.01	.02	ND	ND	ND	ND
Mahala at Jim Cr.	.01	ND	.01	.02	ND	ND	ND	ND
Jim Cr. at Mahala	.01	ND	.01	.02	ND	ND	ND	ND
Jim Cr. at Foothill Road	.01	ND	.01	.02	ND	ND	ND	ND
Mahala at Foothill Road	.01	.01	.02	.02	.02	ND	ND	ND
S. Fork Mahala .02	ND	.01	.02	.02	ND	ND	ND	
N. Fork Mahala .01	ND	.01	.02	.02	ND	ND	ND	

Parameter: NO_3-N

Site	Date: 5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	.04	ND	.02	.02	ND	.03	.04	ND
Mahala at Jim Cr.	1.14	ND	.08	.05	ND	.08	.04	.11
Jim Cr. at Mahala	.28	ND	.43	.03	ND	.12	.02	.12
Jim Cr. at Foothill Road	.40	ND	.54	.03	ND	.08	.03	ND
Mahala at Foothill Road	1.11	.02	1.15	.21	.03	.27	.29	.10
S. Fork Mahala 1.24	ND	1.38	.20	.08	1.35	.26	.19	
N. Fork Mahala 1.57	ND	1.53	.04	.01	.34	.28	.10	

Parameter: TKN

Site	Date: 5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	.44	ND	.30	.39	ND	.50	.40	ND
Mahala at Jim Cr.	2.9	ND	.40	.28	ND	.20	.29	.25
Jim Cr. at Mahala	.62	ND	.60	.28	ND	.40	.36	.34
Jim Cr. at Foothill Road	.49	ND	.60	.29	ND	.20	.33	ND
Mahala at Foothill Road	1.31	.37	1.00	.26	.22	.30	.35	.23
S. Fork Mahala	.52	ND	.50	.18	.11	.30	.33	.23
N. Fork Mahala	.48	ND	.50	.28	.20	.30	.37	.24

Table 2.9. Cont.

Parameter: HCO_3

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	179	ND	249	366	ND	313	312	ND
Mahala at Jim Cr.	184	ND	237	281	ND	241	28.4	280
Jim Cr. at Mahala	73	ND	81.8	96	ND	111	78.8	142
Jim Cr. at Foothill Road	67	ND	73	89.5	ND	117	73.8	ND
Mahala at Foothill Road	178	250	188.5	208	251	235	190	242
S. Fork Mahala	156	ND	174.6	247	353	221	174	219
N. Fork Mahala	195	ND	209.5	156	245	279	215	310

Parameter: Cl

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	6.4	ND	6.5	10.0	ND	13.8	7.36	ND
Mahala at Jim Cr.	3.8	ND	7.0	4.0	ND	7.5	5.07	5.60
Jim Cr. at Mahala	3.2	ND	3.0	2.5	ND	5.0	2.73	8.5
Jim Cr. at Foothill Road	2.7	ND	3.0	1.5	ND	5.0	2.54	ND
Mahala at Foothill Road	3.2	6.0	3.0	4.0	5.0	5.5	3.05	4.8
S. Fork Mahala	2.5	ND	2.3	2.0	3.8	3.0	2.12	5.6
N. Fork Mahala	2.3	ND	2.5	1.5	4.5	4.0	2.06	5.5

Parameter: SO_4

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	28	ND	30	28.1	ND	55	20.6	ND
Mahala at Jim Cr.	35	ND	47	37.1	ND	41	39.2	37
Jim Cr. at Mahala	8.0	ND	10.4	9.0	ND	16	7.3	15
Jim Cr. at Foothill Road	7.0	ND	9.5	9.6	ND	17	6.65	ND
Mahala at Foothill Road	32	6.0	3.0	4.0	5.0	5.5	3.05	4.8
S. Fork Mahala	22	ND	24.8	44	90.8	54	23.9	61.0
N. Fork Mahala	31	ND	27.9	26.5	48.8	82.0	31.6	102

Parameter: Na

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	10.0	ND	12.8	22.9	ND	22.8	15.6	ND
Mahala at Jim Cr.	5.0	ND	10.4	9.2	ND	13.8	9.13	11.1
Jim Cr. at Mahala	5.3	ND	5.25	5.8	ND	7.8	4.78	14.1
Jim Cr. at Foothill Road	4.1	ND	4.6	4.8	ND	6.8	4.35	ND
Mahala at Foothill Road	4.6	7.64	5.1	6.0	8.6	6.8	5.0	7.52
S. Fork Mahala	3.6	ND	3.75	9.8	7.1	5.5	3.72	6.9
N. Fork Mahala	4.2	ND	4.0	4.0	5.7	6.2	4.16	9.08

Table 2.9. Cont.

Parameter: K

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	2.05	ND	2.40	4.40	ND	4.50	4.24	ND
Mahala at Jim Cr.	1.45	ND	1.98	1.40	ND	1.10	2.02	1.82
Jim Cr. at Mahala	1.20	ND	1.24	1.20	ND	1.7	1.07	2.45
Jim Cr. at Foothill Road	1.15	ND	1.35	1.20	ND	1.60	1.12	ND
Mahala at Foothill Road	1.40	2.58	1.33	1.10	1.58	1.40	1.23	1.48
S. Fork Mahala	1.78	ND	1.21	1.28	2.00	1.30	1.14	1.81
N. Fork Mahala	1.26	ND	1.24	1.25	1.88	1.30	1.11	2.16

Parameter: Ca

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	41.5	ND	49.0	67.5	ND	59.0	55.1	ND
Mahala at Jim Cr.	41.5	ND	52.0	59.0	ND	49.0	57.5	58.0
Jim Cr. at Mahala	15.4	ND	17.1	19.4	ND	23.0	15.9	29.2
Jim Cr. at Foothill Road	14.2	ND	16.0	18.0	ND	24.5	14.8	ND
Mahala at Foothill Road	40.0	58.3	41.0	47.5	57.0	52.5	42.4	56.1
S. Fork Mahala	34.2	ND	37.5	54.0	78.5	51.0	35.7	68.0
N. Fork Mahala	46.0	ND	44.0	37.5	57.0	65.0	46.7	79.01

Parameter: Mg

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	18.6	ND	23.0	35.8	ND	29.5	30.4	ND
Mahala at Jim Cr.	19.3	ND	24.5	26.2	ND	22.0	26.6	25.2
Jim Cr. at Mahala	5.8	ND	6.8	7.4	ND	9.5	6.4	9.9
Jim Cr. at Foothill Road	5.4	ND	6.2	7.2	ND	10.0	5.92	ND
Mahala at Foothill Road	18.7	27.8	20.4	23.0	26.6	26.5	21.3	25.6
S. Fork Mahala	16.4	ND	18.3	27.2	38.9	26.2	17.8	33.0
N. Fork Mahala	22.1	ND	22.2	18.5	27.6	35.5	24.4	43.2

Parameter: SiO_2

Site Date:	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Mahala at Highway	15.0	ND	20.4	32.2	ND	27.0	30.0	ND
Mahala at Jim Cr.	10.0	ND	20.2	23.0	ND	20.0	24.0	21.0
Jim Cr. at Mahala	12.0	ND	13.1	15.0	ND	15.0	13.0	27.0
Jim Cr. at Foothill Road	12.0	ND	13.3	13.0	ND	14.0	13.0	ND
Mahala at Foothill Road	10.0	18.1	11.9	11.5	17.9	13.0	12.0	15.0
S. Fork Mahala	8.0	ND	11.2	11.2	14.3	12.0	11.0	12.0
N. Fork Mahala	10.0	ND	11.5	11.0	12.1	10.0	13.0	12.0

Table 2.9. Cont.

Parameter: Cl

Site	Date: 5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	8.0	ND	7.5	ND	ND	27.0	6.95	ND
Sheep at Foothill Road	2.2	ND	2.5	1.0	ND	11.0	2.18	ND

Parameter: SO4

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	26	ND	21	ND	ND	66	21.3	ND
Sheep at Foothill Road	8.0	ND	9.6	8.2	ND	34	6.99	ND

Parameter: Na

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	10.3	ND	11.8	ND	ND	41.2	12.8	ND
Sheep at Foothill Road	3.8	ND	4.25	5.1	ND	11.0	4.01	ND

Parameter: K

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	1.85	ND	1.85	1.82	ND	3.6	2.70	ND
Sheep at Foothill Road	.89	ND	1.12	.80	ND	2.70	.85	ND

Parameter: Ca

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	25.0	ND	25.5	ND	ND	47.0	27.6	ND
Sheep at Foothill Road	16.4	ND	17.5	20.0	ND	29.5	16.8	ND

Parameter: Mg

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	9.8	ND	10.6	ND	ND	17.2	11.5	ND
Sheep at Foothill Road	6.5	ND	7.0	8.6	ND	14.8	7.48	ND

Parameter: SiO_2

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	13.0	ND	14.3	ND	ND	26.0	17.0	ND
Sheep at Foothill Road	10.0	ND	13.0	12.9	ND	13.0	12.0	ND

Table 2.10. Water Quality - Sheep Creek Drainage

Parameter: pH

Site	Date: 5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	8.04	ND	8.41	ND	ND	8.30	8.52	ND
Sheep at Foothill Road	8.04	ND	7.44	8.08	ND	7.90	8.23	ND

Parameter: Turbidity

Sheep at Highway	ND	ND	26.0	ND	ND	260.0	1.0	ND
Sheep at Foothill Road	ND	ND	13.0	3.0	ND	5.5	12.0	ND

Parameter: Elec. Conductivity

Sheep at Highway	245	ND	353	ND	ND	535	278	ND
Sheep at Foothill Road	144	ND	153	181	ND	318	159	ND

Parameter: OPO_4-P

Sheep at Highway	.04	ND	.07	ND	ND	.19	.08	ND
Sheep at Foothill Road	.03	ND	.04	.04	ND	.12	.03	ND

Parameter: Tot. P

Sheep at Highway	.33	ND	.16	ND	ND	.68	.12	ND
Sheep at Foothill Road	.05	ND	.09	.04	ND	.11	.06	ND

Parameter: NH_4-N

Sheep at Highway	.06	ND	.02	ND	ND	ND	ND	ND
Sheep at Foothill Road	.01	ND	.01	.02	ND	ND	ND	ND

Parameter: NO_3-N

Sheep at Highway	.04	ND	.02	ND	ND	.10	.02	ND
Sheep at Foothill Road	.07	ND	.10	.03	ND	.15	.03	ND

Parameter: TKN

Sheep at Highway	1.40	ND	.50	ND	ND	2.20	.35	ND
Sheep at Foothill Road	.33	ND	.70	.28	ND	.40	.28	ND

Parameter: HCO_3

Sheep at Highway	112	ND	108	ND	ND	225	123	ND
Sheep at Foothill Road	77	ND	82.5	106	ND	136	89.5	ND

Table 2.10. Cont.

Parameter: Cl

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	8.0	ND	7.5	ND	ND	27.0	6.95	ND
Sheep at Foothill Road	2.2	ND	2.5	1.0	ND	11.0	2.18	ND

Parameter: SO4

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	26	ND	21	ND	ND	66	21.3	ND
Sheep at Foothill Road	8.0	ND	9.6	8.2	ND	34	6.99	ND

Parameter: Na

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	10.3	ND	11.8	ND	ND	41.2	12.8	ND
Sheep at Foothill Road	3.8	ND	4.25	5.1	ND	11.0	4.01	ND

Parameter: K

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	1.85	ND	1.85	1.82	ND	3.6	2.70	ND
Sheep at Foothill Road	.89	ND	1.12	.80	ND	2.70	.85	ND

Parameter: Ca

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	25.0	ND	25.5	ND	ND	47.0	27.6	ND
Sheep at Foothill Road	16.4	ND	17.5	20.0	ND	29.5	16.8	ND

Parameter: Mg

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	9.8	ND	10.6	ND	ND	17.2	11.5	ND
Sheep at Foothill Road	6.5	ND	7.0	8.6	ND	14.8	7.48	ND

Parameter: SiO_2

Site	5/16/78	8/20/79	5/09/79	6/18/79	8/21/79	3/06/80	5/20/80	9/30/80
Sheep at Highway	13.0	ND	14.3	ND	ND	26.0	17.0	ND
Sheep at Foothill Road	10.0	ND	13.0	12.9	ND	13.0	12.0	ND

interpret these data in terms of biological significance, it is noted that pH and dissolved oxygen levels are within comfortable ranges for regional fisheries. No parameters or sampling stations showed very great fluctuations.

Stream Characterizations

In 1978, the Gance, Mahala, Jim and Sheep Creek drainages were characterized at a number of cross-sections by channel configuration and composition. The original data and working maps are on file, although no summaries or follow-ups are available. A sample of the data is included in the next pages.

Date 7/8/78 Time 1115 Crew R. Scott

PERENNIAL STREAM CLASSIFICATION

Stream Cance Tributary ____ Site 11 Channel Gradient 12%

Snowmelt Flow (.1 ft)		Roughness		Geology	
Width	2.8	(Scale to size of channel)		1) Hard volcanics	
Depth 1/4	.6	Smooth		2) Soft volcanics	
Depth 1/2	.6	Intermediate		3) Hard granitics	
Depth 3/4	.9	Mostly turbulent (riffles and pools)	✓	4) Soft granitics	
				5) Alluvium	✓

Channel Bottom

Composition		Angularity	
Boulders & bedrock (1'-)	5 %	1) Sharp edges + corners, plant surfaces roughened	
Cobbles & Rock (2"-1')	15 %	2) Rounded edges + corners, plane surfaces roughened	✓
Gravel (0.1"-2.0")	30 %	3) Well-rounded in all dimensions, plane surfaces smooth	
Fine sand, silt & clay	50 %		
Fine dead organic	0 %	**Stability (inorganics)**	
Live vegetation		1) Particles packed, resist dislodgement when kicked	
grass & forbs	0 %	2) Moderately packed, some dislodgement when kicked	
shrubs	0 %	3) Unconsolidated, moves easily when walked on	✓

General

Source Area		Sediment Traps	
Veg. type		Area drains into lake	
Veg. density	%	size of lake	(acres)
Area	(acres)	Area drains into meadow	
Slope		flow in channel	
		flow diffuses	
Other		size	(acres)

Lower Banks

Composition	Left	Right
Boulders & bedrock (1'-∞)	5	5
Cobbles & rock (2"-1')	5	5
Gravel (0.1"-2.0")	40	40
Fine sand, silt, clay	30	30
Fine dead organic debris	0	0
Live vegetation		
grass & forbs	20	20
shrubs	0	0

Stability

1) Particles packed, resist dislodgement when kicked ____
2) Moderately packed, some dislodgement when kicked ____
3) Unconsolidated, moves easily when walked on ✓

Cutting	Left	Right
1) Little or none (<10%)	✓	
2) Intermediate		✓
3) Nearly continuous (<75%)		

Upper Bank

Slope	Left	Right
0-30		
30-65		
65+		

length right 4'
left 6'

Mass Wasting	Left	Right
1) No evidence of occurrence		
2) Infrequent or small slumps	✓	✓
3) Frequent slumps, peak flow carries away new material		
4) Mass wasting extensive - large area affected		

Composition	Left	Right
Boulders & Bedrock (1'-)	0	0
Cobbles & rock (2"-1')	10	10
Gravel (0.1"-2.0")	10	10
Fine sand, silt, clay	30	30
Fine dead organic debris	0	0
Live vegetation		
grass & forbs	50	50
shrubs	0	0

Stability (inorganics)	Left	Right
1) surface strongly resistant; 2mm		
2) surface moderately resistant		
3) surface not aggregate; single grain		

veg: aspens, snowberry
forbs, grasses

Current Data

Sta.	Dist.	Depth	Time	Count
1				
2				
3				
4	est.	.75	cfs	
5				
6				
7				
8				
9				

CHAPTER 3

A TEST OF NEVADA INTERAGENCY RIPARIAN CLASSIFICATION SYSTEM

Desi Zemudio and Sherman Swanson

The intent of this research is to test aspects of the proposed Nevada Interagency Classification of Riparian Areas. The Nevada approach is an interdisciplinary hierarchical classification system. The initial research direction was to focus on higher levels of the hierarchy. The wetland types and stream type components were selected for study.

Stream type data were gathered using the Rosgen (1985) methodology. Wetland type data were gathered as soil pedons with soil moisture data. Gypsum blocks and observation wells were installed at pedon sites. Only late season moisture values were obtained.

Preliminary Results

Data were collected along California, Gance, Mahala, Jim and Sheep Creeks. The stream gradient ranged from 0.815% to 5.93%. Jim Creek (9 sites) ranged from 0.815% to 3.80%. Seven sites on Sheep Creek ranged from 1.27% to 5.93%. The ridge to trough soil geomorphic form was observed at the majority of these sites. In 1987 these patterns will be used to group wetland types by position.

Stream	Sites	Rosgen Stream Types Sampled
California	2	A3, A3
Gance	3	B3, B3, B2
Jim	9	B3, B3, B3, B3, B4, B5, C3, B5, B2
Mahala	3	C3, B5, B5
Sheep	7	C3, A2, A3, A3, B2, B5, B3

Stream	Soil Pedons	Wells	Moisture Cells
California	6	4	4
Gance	15	12	6
Jim	43	26	18
Mahala	16	13	6
Sheep	27	12	14

Reference

Rosgen, D.L. 1985. A Stream Classification System. Riparian Ecosystem and Their Management: Reconciling Conflicting Uses. Proc. of Symp., Tuscon, AZ.

CHAPTER 4

FISHERIES RESEARCH

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Introduction

Fiscal year 1986 study goals for fisheries research comprised continuation of time trend analyses of aquatic and streamside habitat conditions on Gance Creek, the relationship of local cattle management to these conditions, and their influences on the dynamics of the indigenous population of Lahontan cutthroat trout (*Salmo clarki henshawi*). These goals were in line with the overall objectives of the Saval Ranch Research and Evaluation Project and the Livestock-Fishery Interaction Studies being conducted by the U.S. Department of Agriculture, Forest Service. Specific overall objectives included:

1. Evaluate trends in streambank, channel, and water column structural attributes on Gance Creek under normal and non-use grazing.

2. Evaluate trends in structure and use of riparian vegetation on Gance Creek under normal and non-use grazing.

3. Evaluate the compatibility of current and historic grazing strategies with the survival of the indigenous trout population in Gance Creek.

4. Evaluate the potential for enhancing or otherwise rehabilitating fishery conditions on Gance Creek to increase fish production.

5. Make recommendations concerning optimum grazing strategies with respect to the promotion of high quality streamside and aquatic habitat on Gance Creek.

Specific objectives for 1986 included:

1. Annual collection of structural (geomorphic, aquatic, and riparian), streamside forage, and fish population data.

2. Compare 1986 data with that of past years, investigate any trends that may be emerging as our information base develops, and summarize annual results and overall conclusions relating to fisheries management on Gance Creek.

3. Attempt to identify and discuss any extraneous factors that may be influencing local fishery conditions.

4. Make recommendations regarding potential refinements in study design in improve efficiency and maintain consistency with the overall objectives of the Saval Ranch Project should the project be extended beyond 1986.

Table 4.2. Annual structural and riparian attribute means, 1978-1986, Gance Creek, Nevada.

Site 1										
Variable	1978	1979	1980	1981	1982	1983	1984	1985	)986	Avg
Water Column										
Stra. wid. (ft)	5.1	5.2	6.0	5.9	6.3	6.5	7.5	6.4	7.3	6.2
Chan. wid. (ft)	NA	NA	NA	NA	NA	NA	10.0	NA	NA	10.0
Stra. depth (ft)	0.19	0.22	0.24	0.22	0.29	0.30	0.30	0.24	0.25	0.25
Riffle wid. (pct)	69.4	73.7	43.1	60.6	26.4	36.8	54.7	65.1	58.9	54.3
Pool wid. (pct)	30.6	26.3	56.9	38.8	73.6	63.2	45.3	34.9	41.1	45.6
Pool quality	1.9	).6	2.5	1.9	3.0	2.8	2.4	1.1	1.9	2.1
Pool feature	1.2	1.0	1.0	4.2	3.8	5.0	5.1	3.1	4.6	3.2
P:R ratio	0.4	0.4	1.3	0.6	2.8	1.7	0.8	0.5	0.7	1.0
W:D ratio	26.8	23.6	25.0	26.8	21.7	21.7	25.0	26.7	29.2	25.2
Streambanks										
Bank angle (deg)	126	107	114	)11	117	120	116	136	)28	119
Bank undercut (ft)	0.06	0.20	0.17	0.22	0.19	0.21	0.23	0.09	0.16	0.17
Shore depth (ft)	0.05	0.10	0.12	0.08	0.10	0.14	0.13	0.04	0.09	0.09
Fisheries rating	1.1	1.4	1.8	1.6	2.1	2.3	NA	NA	NA	1.7
Streambottom										
Embeddedness (rank)	3.1	3.5	2.1	3.4	2.4	2.9	2.6	NA	NA	2.9
(pct)	NA	NA	NA	NA	NA	NA	NA	58.1	65.0	6).6
Total Fines (pct)	18.6	16.2	17.6	13.4	12.0	11.1	17.1	19.5	18.4	16.0
Fines (0.03in (pct)	10.5	11.4	15.9	10.6	6.2	6.9	13.9	12.6	14.9	11.4
Fines)0.03in (pct)	8.1	4.8	1.7	2.8	5.8	4.2	3.2	6.9	3.5	4.6
Gravel (pct)	76.5	67.1	70.7	74.0	72.5	67.4	60.7	49.1	65.0	67.0
Rubble (pct)	3.6	13.)	9.4	10.8	13.4	20.9	20.0	29.1	13.4	14.9
Boulder (pct)	1.3	3.2	2.3	1.7	2.1	1.7	2.3	2.4	3.2	2.2
Instrm veg cov (ft)	0.3	0.3	0.2	0.0	0.6	0.4	0.5	0.2	1.1	0.4
Riparian										
Stream cover	2.7	3.0	1.9	2.4	2.7	2.0	2.3	1.8	1.9	2.3
Bank stab (rank)	1.3	1.9	2.2	2.1	2.5	2.4	2.3	NA	NA	2.1
(pct)	NA	NA	NA	NA	NA	NA	NA	35.0	40.5	37.8
Habitat type	6.8	12.1	10.4	12.4	15.2	NA	NA	9.8	8.9	10.8
Vegatative use (pct)	68	73	46	75	55	42	11	60	41	52
Alteration (pct)										
Natural	29	27	32	27	33	25	37	30	NA	30
Artificial	21	14	16	17	13	12	9	24	NA	16
Total	50	41	48	44	46	37	46	54	60	47
Veg. overhang (ft)	0.09	0.18	0.07	0.15	0.33	0.18	0.06	0.00	0.09	0.13
Canopy (deg)	NA	NA	NA	NA	40	48	NA	NA	NA	44
Light intens (pct)	NA	NA	NA	NA	61	71	NA	NA	NA	66
Heat (BTU/ft^2/day)	NA	NA	NA	NA	NA	NA	1088	NA	NA	1088

Site 2										
Variable	1978	1979	1980	1981	1982	1983	1984	1985	1986	Avg
Water Column										
Stra. wid. (ft)	6.0	5.6	6.5	6.1	5.9	6.4	7.6	6.8	7.3	6.5
Chan. wid. (ft)	NA	NA	NA	NA	NA	NA	9.5	NA	NA	9.5
Stra. depth (ft)	0.22	0.22	0.25	0.22	0.23	0.29	0.30	0.22	0.24	0.24
Riffle wid. (pct)	78.4	78.6	48.3	77.8	41.9	38.8	61.4	66.8	59.2	61.2
Pool wid. (pct)	21.6	21.4	51.7	22.0	58.1	61.2	38.6	33.2	40.8	38.7
Pool quality	1.9	1.8	2.5	1.3	2.3	2.7	2.2	1.2	1.8	2.0
Pool feature	1.0	1.0	1.0	3.4	4.6	5.0	4.9	3.6	5.3	3.3
P:R ratio	0.3	0.3	1.1	0.3	1.4	1.6	0.6	0.5	0.7	0.7
W:D ratio	27.3	25.5	26.0	27.7	25.7	22.1	25.3	30.9	30.4	26.8
Streambanks										
Bank angle (deg)	123	95	121	127	116	108	98	116	114	113
Bank undercut (ft)	0.09	0.33	0.18	0.16	0.23	0.28	0.45	0.22	0.26	0.24
Shore depth (ft)	0.04	0.07	0.10	0.05	0.07	0.13	0.15	0.08	0.08	0.09
Fisheries rating	1.1	).6	1.7	1.6	1.7	2.5	NA	NA	NA	1.7
Streambottom										
Embeddedness (rank)	3.6	4.0	2.7	4.1	3.1	2.7	2.6	NA	NA	3.3
(pct)	NA	NA	NA	NA	NA	NA	NA	53.3	58.1	55.7
Total Fines (pct)	10.3	7.0	11.5	6.6	5.9	6.9	9.7	13.6	12.4	9.3
Fines (0.03in (pct)	8.6	4.5	9.3	5.6	2.2	3.9	5.5	5.0	9.4	6.0
Fines)0.03in (pct)	1.7	2.5	2.2	1.0	3.7	3.0	4.2	8.6	3.0	3.3
Gravel (pct)	80.3	63.6	66.6	72.0	67.4	56.9	51.2	50.9	56.0	62.8
Rubble (pct)	8.3	22.5	14.3	14.1	18.2	26.2	26.4	26.1	17.3	19.3
Boulder (pct)	1.1	7.3	7.7	7.3	8.5	11.0	12.9	9.5	14.2	8.8
Instrm veg cov (ft)	0.1	0.3	0.3	0.0	0.2	0.3	0.2	0.1	0.4	0.2
Riparian										
Stream cover	2.4	2.5	1.9	1.9	2.5	1.8	2.4	1.7	1.8	2.1
Bank stab (rank)	1.4	1.6	2.3	2.1	2.9	2.2	2.2	NA	NA	2.1
(pct)	NA	NA	NA	NA	NA	NA	NA	32.2	39.9	36.1
Habitat type	6.1	7.9	10.1	12.1	15.4	NA	NA	7.1	7.7	9.5
Vegatative use (pct)	53	15	)0	)55	1	0	0	15	2	10
Alteration (pct)										
Natural	30	32	36	30	24	28	39	41	NA	33
Artificial	15	9	0	11	7	1	2	9	NA	7
Total	45	41	36	4!	31	29	41	50	55	41
Veg. overhang (ft)	0.14	0.12	0.14	0.13	0.37	0.18	0.07	0.12	0.14	0.16
Canopy (deg)	NA	NA	NA	NA	26	24	NA	NA	NA	25
Light intens (pct)	NA	NA	NA	NA	60	56	NA	NA	NA	58
Heat (BTU/ft^2/day)	NA	NA	NA	NA	NA	NA	610	NA	NA	610

Site 3										
Variable	1978	1979	1980	1981	1982	1983	1984	1985	1986	Avg
Water Column										
Stra. wid. (ft)	4.5	5.5	6.4	6.2	5.6	6.7	7.3	5.8	6.9	6.1
Chan. wid. (ft)	NA	NA	NA	NA	NA	NA	9.3	NA	NA	9.3
Stra. depth (ft)	0.15	0.19	0.21	0.21	0.21	0.27	0.29	0.21	0.26	0.22
Riffle wid. (pct)	70.6	75.3	53.1	74.1	36.2	43.5	57.5	73.9	48.3	59.2
Pool wid. (pct)	29.4	24.7	46.9	25.9	63.8	56.5	42.5	26.1	51.7	40.8
Pool quality	1.6	1.8	2.2	1.5	2.8	2.6	2.1	1.1	2.3	2.0
Pool feature	1.6	1.8	2.2	1.5	2.8	2.6	2.1	1.1	4.4	2.2
P:R ratio	0.4	0.3	0.9	0.3	1.8	1.3	0.7	0.4	1.1	0.8
W:D ratio	30.0	28.9	30.5	29.5	26.7	24.8	25.2	27.6	26.5	27.8
Streambanks										
Bank angle (deg)	141	114	126	135	122	119	114	137	121	125
Bank undercut (ft)	0.08	0.14	0.14	0.10	0.13	0.22	0.29	0.11	0.19	0.16
Shore depth (ft)	0.03	0.04	0.10	0.05	0.06	0.10	0.11	0.03	0.08	0.07
Fisheries rating	1.5	1.4	1.7	1.5	1.8	2.1	NA	NA	NA	1.7
Streambottom										
Embeddedness (rank)	3.8	4.2	3.1	3.9	2.7	2.9	2.4	NA	NA	3.3
(pct)	NA	NA	NA	NA	NA	NA	NA	47.2	58.3	52.8
Total Fines (pct)	9.1	11.1	18.5	15.4	15.7	11.9	14.1	13.1	15.1	13.8
Fines (0.03in (pct)	1.2	4.7	14.8	9.6	7.1	7.2	8.0	4.8	11.3	7.6
Fines)0.03in (pct)	7.9	6.4	3.7	5.8	8.6	4.7	6.1	8.3	3.8	6.1
Gravel (pct)	86.2	78.3	74.8	80.5	79.0	68.6	60.7	65.7	67.2	73.4
Rubble (pct)	3.0	6.3	3.1	1.8	1.7	13.7	19.7	18.9	11.5	8.9
Boulder (pct)	1.7	4.3	3.6	2.1	3.6	5.8	6.1	2.3	6.2	4.0
Instrm veg cov (ft)	0.3	0.6	0.3	0.0	0.4	0.5	0.5	0.1	0.5	0.4
Riparian										
Stream cover	2.7	2.5	1.8	1.9	2.4	1.8	2.2	1.5	1.8	2.1
Bank stab (rank)	2.2	1.6	2.2	2.0	2.5	1.9	2.2	NA	NA	2.1
(pct)	NA	NA	NA	NA	NA	NA	NA	26.2	33.0	29.6
Habitat type	12.0	8.5	10.6	10.8	13.5	NA	NA	7.5	7.4	10.0
Vegatative use (pct)	59	48	42	75	56	35	2	55	28	44
Alteration (pct)										
Natural	31	29	33	25	27	25	42	36	NA	31
Artificial	50	42	45	40	43	33	50	58	NA	45
Total	81	71	78	65	70	58	92	94	58	74
Veg. overhang (ft)	0.06	0.08	0.14	0.06	0.28	0.97	0.05	0.06	0.04	0.19
Canopy (deg)	NA	NA	NA	NA	38	33	NA	NA	NA	36
Light intens (pct)	NA	NA	NA	NA	59	62	NA	NA	NA	61
Heat (BTU/ft^2/day)	NA	NA	NA	NA	NA	NA	773	NA	NA	773

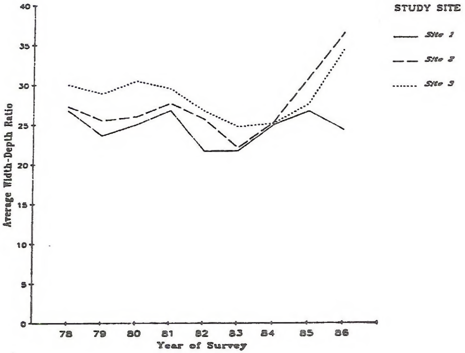


Figure 4.1. Annual fluctuations in width-depth ratio (W:D), Gance Creek, Nevada, 1978-1986.

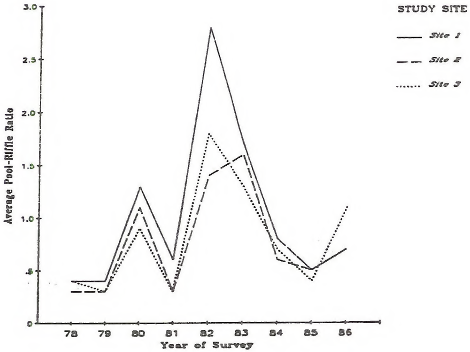


Figure 4.2. Annual fluctuations in pool-riffle ratio (P:R), Gance Creek, Nevada, 1978-1986.

Streambank Attributes

Average streambank angles declined in all three study sites in 1986, but remained uniformly greater than 90. The smallest decrease was observed in the treatment site (site 2), which had the lowest average streambank angle in the study area. Only in site one was the average angle for 1986 larger than the long-term average angle. Streambank angle in that site has undergone a general increase since 1979. In contrast, average annual bank angles in the other two sites have fluctuated with less directional tendency.

Despite the ambiguous behavior of average bank angles, streambank undercuts increased relative to 1985 and seem generally to be improving (Figure 4.3). This is particularly apparent in site 2 where average undercut has exceeded its long-term mean value for three of the past four seasons. Site 2 also had the highest long-term average undercut and the highest value recorded in 1986.

Shore depth depends upon stream depth as well as on the condition of the bank itself, so it is not surprising that average streamshore depth generally increased in 1986. The only site in which shore depth did not increase was the treatment site, which showed the least change in all structural bank attributes, providing further evidence for that site's apparently greater overall stability. Site 1 exhibited the greatest long-term average streamshore depth, site 3 the lowest.

It must be noted that Gance Creek is an unstable stream system that has undergone rapid and radical channel geometry changes during the course of this study (see Platts et al. 1985 and previous editions of this report). In particular, extensive downcutting dramatically affects streambank appearances and changes angles, undercuts, and shore depths on an annual basis. Consequently, large annual fluctuations in channel geometry will continue to produce these fluctuations in streambank attributes.

Streambottom Attributes

Gravel continued to compose the bulk of the streambottom surface sediments in 1986, and its relative abundance may be returning to long-term average values. Gravel began a general decline throughout the study area in 1982, but an apparent upturn was observed in 1986 (Figure 4.4). This upswing seemed to occur largely at the expense of rubble, whose relative abundance declined in 1986 after several years of increasing or stable levels. Site 3, the upper control, continued to contain the largest proportion of gravel with respect to both 1986 (67.2%) and long-term average (73.4%) levels. Total abundance of fine sediments appeared to be increasing over time in site 2, while fluctuating with no apparent trend in the two control sites. However, 1986 levels exceeded long-term average composition, having the highest proportions of rubble and boulder and the lowest proportion of fine sediments. Since fines have increased somewhat in this site, the condition is probably inherent and not due to the exclusion of grazing.

Instream vegetative cover fluctuated without any apparent trend over the course of the study, and was relatively abundant in 1986. All three sites had above-average amounts of instream cover in 1986, and sites 1 and 2 both registered their highest levels of the study. These two sites were 175% and 100%, respectively, above their long-term average levels.

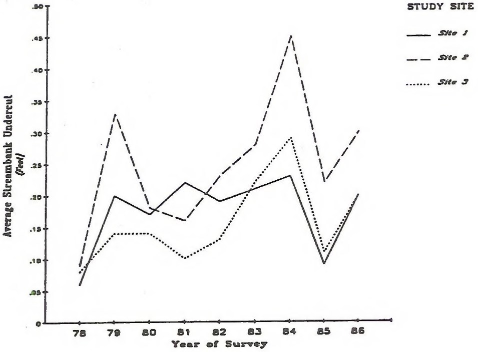


Figure 4.3. Annual fluctuations in streambank undercut, Gance Creek, Nevada, 1978-1986.

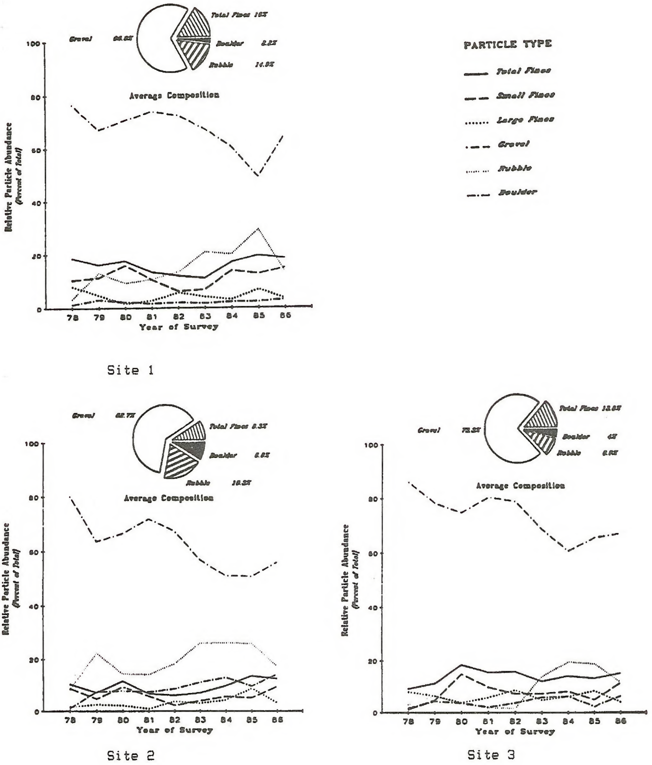


Figure 4.4. Annual fluctuations (line graphs) in streambottom sediment composition and long-term average proportions (inset pie graphs) by study site, Gance Creek, Nevada, 1978-1986.

Riparian Vegetation Attributes

Vegetation use by livestock was unusually low in 1986, and very low (28%) in site 3. This was 36% below the long-term average intensity for site 3 (44%), and even site 1 had an intensity of just 41%, 21% under its long-term average level. Both of these average values include one other low-use season (1984), further indicating that use in 1986 was well below usual levels.

Streambank Alteration

The study area section of Gance Creek continued to represent a highly altered system, and long-term average values ranged from a low of 47% in site 1 to a high of 74% in site 3. Streambank alteration (total) has generally edged upward since 1983, before which time it had been declining somewhat (Figure 4.5). Only in site 3 did total alteration decline between 1985 and 1986, where it dropped 38%. Natural and artificial sources of alteration were not distinguished in 1986, but past data indicate that most of the alteration in site 3 was artificially induced; reduced grazing in 1986 may have rendered such alteration less pronounced.

Streamside Herbage Analysis

Graphing of 1986 herbage meter readings against green vegetation weights (Figure 4.6) suggested a simple linear relationship, and a linear model was fit to the data (Table 4.3). The linear model provided a good fit to the data, but the coefficient of determination (R^2) was somewhat lower than in most previous years. This reduced R^2 value of 0.79, together with the above-average residual error ($S_{y.x}$), suggest considerable heterogeneity in the vegetation. This was probably induced by good growth conditions created by abundant soil moisture because of above-average winter snowfall. In addition, the downcutting that is occurring on Gance Creek may be inducing greater variety in the sampled vegetation.

Growing conditions for streamside vegetation were apparently quite good, because production was high in all sites, and 1986 recorded the second highest ungrazed streamside forage production we encountered during the study. The 1986 production of 2496 lb/acre was 74% greater than the 8-year average production of 1432 lb/acre. Yield differentials between sites suggest that visual estimations of forage use may have underestimated actual use slightly, but inherent yield differences between sites have not been sufficiently identified to quantify the discrepancy. In addition, Gance Creek has downcut so much that metered sites are well removed from the water's edge where visual estimates are taken, and may reflect an area of lower productivity and heavier use because of easier access by cattle.

Overhanging Vegetation and Canopy

Overhanging vegetative cover continued to be scarce within the study area, and seems generally to have decreased over time. Although there was one season of very abundant overhang (1982), there was relatively little in 1986 overall, and in site 3 it was nearly absent. Interestingly, it is this same site 3 that had the highest long-term levels. Downcutting of the stream channel may be implicated in the reduction in effective overhang, because this measurement

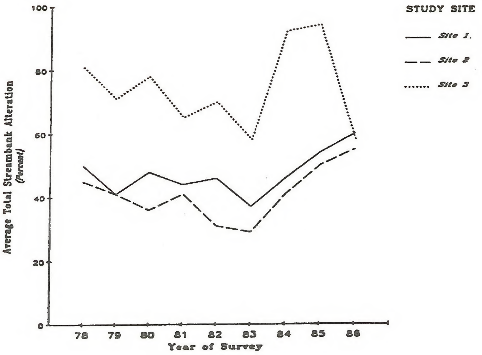


Figure 4.5. Annual fluctuations in total streambank alteration, Gance Creek, Nevada, 1978-1986.

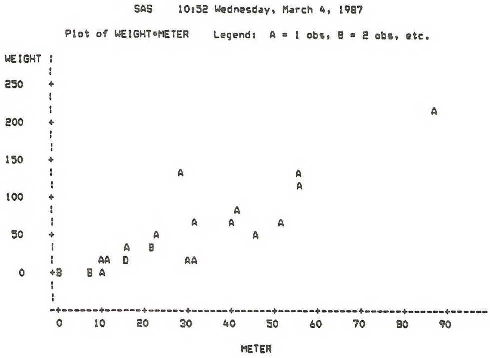


Figure 4.6. Scatter diagram of green herbage weight <u>vs</u>. meter reading, Gance Creek, Nevada, 1986.

Table 4.3. Linear regression analyses of streamside forage weight on herbage meter readings, Gance Creek, Nevada, 1978-1986.

	Linear Regression Model					Herbage Production (lb/acre)			Yield Differential (Percent)	
Year	N	A	B	R^2	S(y.x)	Site 1	Site 2	Site 3	2-1	2-3
1979	15	-0.08	0.03	0.88	0.14	470	490	NA	4	NA
1980	17	0.21	0.07	0.83	0.72	1413	2761	1541	49	44
1981	16	0.04	0.04	0.89	0.12	470	619	544	24	12
1982	24	0.08	0.04	0.87	0.44	906	1530	611	41	60
1983	22	0.46	0.01	0.72	0.42	1036	1345	981	23	27
1984	24	0.10	0.02	0.90	0.34	1118	1240	799	10	36
1985	26	0.16	0.02	0.81	0.26	635	971	637	35	34
1986	26	-0.51	0.08	0.79	0.89	1063	2496	1488	57	40

registers only that vegetation within 1 foot of the stream surface. Lowering of the stream surface relative to existing vegetation will therefore reduce the amount measured, as well as the effectiveness of the existing vegetation to provide needed fish cover.

Preliminary evaluation of thermal input derived from data collected in 1984 suggests that the riparian overstory along Gance Creek is highly effective in reducing solar heating, particularly within the treatment site. The observed thermal input levels (all less than 1100 BTU/ft^2/day and as low as 610 BTU/ft^2/day in the treatment site) are well below many other Great Basin streams we have studied (Platts and Nelson in prep.).

Fish Populations

The cutthroat trout population in Gance Creek (Tables 4.4 and 4.5) seem to fluctuate with a periodicity of 3 to 4 years (Figure 4.7) and reached a very low point in 1986. No specific habitat feature can be shown to control this behavior, and some density-dependent factors appear to be involved. Average trout condition as estimated by condition factors fluctuated similarly to population numbers, but with an approximately one year time lag (Figure 4.8). Thus, peak population condition occurs with population lows while minimal condition tends to coincide with population peaks. Precise mechanisms for this population regulation are presently unknown, as are the modifying effect of habitat conditions.

Trout density and biomass, whether expressed areally (Figure 4.9) or volumetrically (Figure 4.10), showed fluctuations over time that were similar to those of estimated population size. One interesting consequence of looking at both density and biomass, however, was the revelation that although site 3 supported much higher trout densities than site 1 and 2 prior to 1982, biomass in all three sites was generally similar. This resulted from a higher concentration of young-of-the year (YOY) individuals in site 3 prior to 1982, as evidenced by the lower mean trout weights in site 3 during that period. Since 1982, mean weights in all sites have tended toward parity, though site 3 continues to have some tendency to concentrate smaller individuals.

Sculpin numbers, which had appeared to be increasing, plunged in 1986 (Figure 4.11), and exceeded trout numbers only in the ungrazed treatment site. Sculpin typically prefer substrate conditions similar to those preferred by trout, so the relatively good streambottom conditions and the small annual fluctuations in the relative abundances of substrate size classes seems inadequate to account for variations in sculpin numbers. Since the trout population also declined in 1986, population reduction through predation by trout is also unlikely. Some species of sculpin are known to prefer riffle areas to pools (Bailey 1952; Brynildson and Brynildson 1978), and there has been some tendency for fluctuations in sculpin numbers to parallel fluctuations in P:R; however, it is unclear at this time whether this is more than coincidence.

Summary

The inherently variable nature of Great Basin streams and the effects of high spring runoff were again reflected in the riparian-stream habitat conditions of Gance Creek. Nine years of monitoring these conditions have shown that

Table 4.4. Summary of fish population analysis results for 1986, Gance Creek, Nevada.

	Site 1			Site 2			Site 3		
Variable	Value	Std. Dev.	95% C.I.	Value	Std. Dev.	95% C.I.	Value	Std. Dev.	95% C.I.
Cutthroat Trout									
Total catch	103	NA	NA	95	NA	NA	156	NA	NA
Pop. estimate	104	1.48	358 - 382	102	4.58	95 - 111	164	4.39	156 - 173
Mean length (in)	3.69	1.75	NA	3.28	1.56	NA	3.23	1.74	NA
Mean weight (oz)	0.48	0.74	NA	0.36	0.73	NA	0.37	0.72	NA
Estimated biomass									
(oz/ft^2 x 0.01)	1.1	NA	NA	0.8	NA	NA	1.5	NA	NA
(oz/ft^3 x 0.01)	3.8	NA	NA	4.2	NA	NA	7.3	NA	NA
Estimated density									
(#/ft^2 x 0.01)	2.4	NA	NA	2.3	NA	NA	4.0	NA	NA
(#/ft^3 x 0.01)	7.9	NA	NA	11.6	NA	NA	19.8	NA	NA
(#/mile)	915	NA	NA	898	NA	NA	1443	NA	NA
Population condition	0.9	NA	NA	0.9	NA	NA	0.9	NA	NA
Sculpin									
Total catch	104	NA	NA	114	NA	NA	37	NA	NA
Pop. estimate	107	2.53	104 - 112	140	13.01	114 - 166	40	3.27	37 - 47
Mean weight (oz)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Observed biomass									
(oz/ft^2 x 0.01)	NA	NA	NA	NA	NA	NA	NA	NA	NA
(oz/ft^3 x 0.01)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Observed density									
(#/ft^2 x 0.01)	2.4	NA	NA	2.6	NA	NA	0.9	NA	NA
(#/ft^3 x 0.01)	7.9	NA	NA	13.0	NA	NA	4.8	NA	NA
(#/mile)	915	NA	NA	1003	NA	NA	326	NA	NA
Dace									
Total catch	0	NA	NA	0	NA	NA	0	NA	NA
Pop. estimate	0	NA	NA	0	NA	NA	0	NA	NA
Mean weight (oz)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Observed biomass									
(oz/ft^2 x 0.01)	NA	NA	NA	NA	NA	NA	NA	NA	NA
(oz/ft^3 x 0.01)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Observed density									
(#/ft^2 x 0.01)	0.0	NA	NA	0.0	NA	NA	0.0	NA	NA
(#/ft^3 x 0.01)	0.0	NA	NA	0.0	NA	NA	0.0	NA	NA
(#/mile)	0	NA	NA	0	NA	NA	0	NA	NA

Table 4.5. Summary of annual fish population attributes, 1978-1986, Gance Creek, Nevada.

Variable	Site 1 1978	1979	1980	1981	1982	1983	1984	1985	1986	Avg.
Cutthroat Trout										
Total catch	32	175	303	203	183	156	325	133	103	179
Pop. estimate	32	181	327	207	191	166	329	136	104	186
Mean length (in)	4.47	2.42	2.66	3.39	2.87	2.86	2.61	4.16	3.69	3.24
Mean weight (oz)	0.97	0.39	0.36	0.40	0.31	0.27	0.19	0.58	0.48	0.44
Estimated biomass										
(oz/ft^2 x 0.01)	1.0	2.3	3.3	2.3	1.6	1.1	1.4	2.1	1.1	1.8
(oz/ft^3 x 0.01)	5.3	10.3	13.6	10.6	5.4	3.8	4.6	8.6	3.8	7.3
Estimated density										
(#/ft^2 x 0.01)	1.0	5.8	9.1	5.8	5.1	4.3	7.3	3.5	2.4	4.9
(#/ft^3 x 0.01)	5.5	26.4	37.8	26.6	17.4	14.2	24.4	14.8	7.9	19.4
(#/mile)	282	1593	2878	1822	1681	1461	2895	1197	915	1636
Population condition	1.0	0.8	0.9	1.0	1.4	1.3	0.8	1.0	0.9	1
Sculpin										
Total catch	203	17	53	37	94	43	100	155	104	90
Pop. estimate	203	29	54	38	115	47	116	275	107	109
Mean weight (oz)	0.05	0.20	NA	0.20	0.16	0.23	NA	NA	NA	NA
Observed biomass										
(oz/ft^2 x 0.01)	0.3	0.1	NA	0.2	0.4	0.3	NA	NA	NA	NA
(oz/ft^3 x 0.01)	1.7	0.5	NA	1.0	1.4	0.8	NA	NA	NA	NA
Observed density										
(#/ft^2 x 0.01)	6.6	0.5	1.5	1.0	2.5	1.1	2.2	4.0	2.4	2.4
(#/ft^3 x 0.01)	34.9	2.5	6.1	4.8	8.6	3.7	7.4	16.8	7.9	10.6
(#/mile)	1786	150	466	326	827	378	880	1364	915	788
Dace										
Total catch	0	0	0	0	0	0	0	1	0	0
Pop. estimate	NA	NA	NA	NA	NA	NA	NA	1	0	NA
Mean weight (oz)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0	0.0
Observed biomass										
(oz/ft^2 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(oz/ft^3 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.0.	0.0	0.0	0.0
Observed density										
(#/ft^2 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(#/ft^3 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
(#/mile)	0	0	0	0	0	0	0	9	0	1

Variable	Site 2 1978	1979	1980	1981	1982	1983	1984	1985	1986	Avg.
Cutthroat Trout										
Total catch	64	184	294	288	170	102	378	203	95	198
Pop. estimate	64	203	303	299	185	104	379	206	102	205
Mean length (in)	3.57	2.19	2.82	2.73	2.72	3.14	2.34	3.65	3.28	2.94
Mean weight (oz)	0.73	0.31	0.47	0.23	0.24	0.39	0.14	0.41	0.36	0.36
Estimated biomass										
(oz/ft^2 x 0.01)	1.3	1.9	3.7	1.9	1.3	1.1	1.2	2.1	0.8	1.7
(oz/ft^3 x 0.01)	5.9	8.5	14.6	8.5	5.5	3.6	3.9	9.4	4.2	7.1
Estimated density										
(#/ft^2 x 0.01)	1.8	6.0	7.8	8.2	5.2	2.7	8.3	5.0	2.3	5.3
(#/ft^3 x 0.01)	8.1	27.5	31.1	37.1	22.7	9.3	27.7	23.0	11.6	22.0
(#/mile)	563	1786	2666	2631	1628	915	3335	1813	898	1804
Population condition	1.0	0.8	0.9	0.9	1.4	1.1	0.8	0.9	0.9	1
Sculpin										
Total catch	1	2	5	27	29	8	24	204	114	46
Pop. estimate	1	2	5	27	47	9	25	436	140	77
Mean weight (oz)	0.00	0.00	NA	0.10	0.20	0.10	NA	NA	NA	NA
Observed biomass										
(oz/ft^2 x 0.01)	0.0	0.0	NA	0.1	0.2	0.0	NA	NA	NA	NA
(oz/ft^3 x 0.01)	0.0	0.0	NA	0.3	0.7	0.1	NA	NA	NA	NA
Observed density										
(#/ft^2 x 0.01)	0.0	0.1	0.1	0.7	0.8	0.2	0.5	5.0	2.6	0.9
(#/ft^3 x 0.01)	0.1	0.3	0.5	3.4	3.6	0.7	1.8	22.7	13.0	4.1
(#/mile)	9	18	44	238	255	70	211	1795	1003	405
Dace										
Total catch	0	4	0	0	0	0	0	0	0	0.5
Pop. estimate	NA	4	NA	NA	NA	NA	NA	NA	0	NA
Mean weight (oz)	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Observed biomass										
(oz/ft^2 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(oz/ft^3 x 0.01)	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Observed density										
(#/ft^2 x 0.01)	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(#/ft^3 x 0.01)	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
(#/mile)	0	35	0	0	0	0	0	0	0	4

Variable	Site 3 1978	1979	1980	1981	1982	1983	1984	1985	1986	Avg.
Cutthroat Trout										
Total catch	110	216	472	524	126	201	376	161	156	260
Pop. estimate	111	235	506	533	143	206	383	164	164	272
Mean length (in)	2.46	1.98	2.09	2.56	2.62	2.77	2.62	3.79	3.23	2.68
Mean weight (oz)	0.22	0.11	0.20	0.17	0.18	0.22	0.19	0.44	0.37	0.23
Estimated biomass										
(oz/ft^2 x 0.01)	0.9	0.8	2.6	2.4	0.8	1.1	1.7	2.1	1.5	1.5
(oz/ft^3 x 0.01)	6.0	4.1	12.5	11.6	3.6	4.2	5.7	9.9	7.3	7.2
Estimated density										
(#/ft^2 x 0.01)	4.1	7.1	13.2	14.3	4.3	5.1	8.7	4.7	4.0	7.3
(#/ft^3 x 0.01)	27.4	37.5	62.7	68.2	20.3	19.0	30.2	22.4	19.8	34.2
(#/mile)	977	2068	4453	4690	1258	1813	3370	1443	1443	2391
Population condition	1.0	0.7	0.9	0.9	1.4	1.0	0.9	0.9	0.9	1
Sculpin										
Total catch	0	1	0	0	0	2	16	185	37	27
Pop. estimate	0	1	0	0	0	2	16	303	40	40
Mean weight (oz)	0.00	<0.1	NA	0.00	0.00	<0.1	NA	NA	NA	NA
Observed biomass										
(oz/ft^2 x 0.01)	0.0	0.0	NA	0.0	0.0	0.0	NA	NA	NA	NA
(oz/ft^3 x 0.01)	0.0	0.0	NA	0.0	0.0	0.0	NA	NA	NA	NA
Observed density										
(#/ft^2 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.4	5.3	0.9	0.7
(#/ft^3 x 0.01)	0.0	0.2	0.0	0.0	0.0	0.2	1.3	25.3	4.8	3.4
(#/mile)	0	9	0	0	0	18	141	1628	326	236
Dace										
Total catch	0	0	0	0	0	0	4	1	0	1
Pop. estimate	NA	NA	NA	NA	NA	NA	4	1	0	NA
Mean weight (oz)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0	0.0
Observed biomass										
(oz/ft^2 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(oz/ft^3 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Observed density										
(#/ft^2 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
(#/ft^3 x 0.01)	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.1
(#/mile)	0	0	0	0	0	0	35	9	0	6

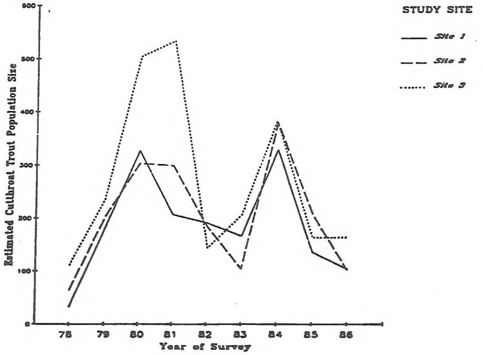


Figure 4.7. Annual fluctuations in estimated cutthroat trout population size, Gance Creek, Nevada, 1978-1986.

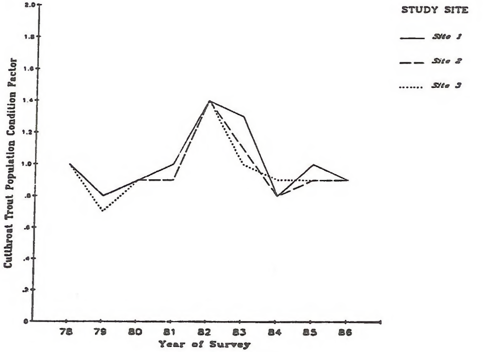
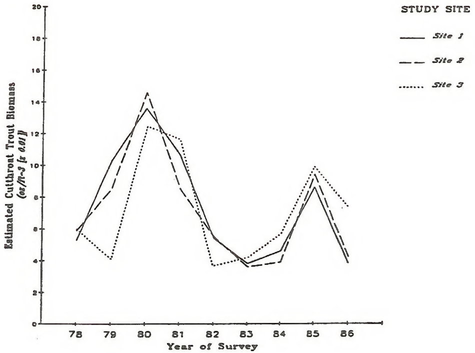


Figure 4.8. Annual fluctuations in average trout population condition factors, Gance Creek, Nevada, 1978-1986.

a.



b.

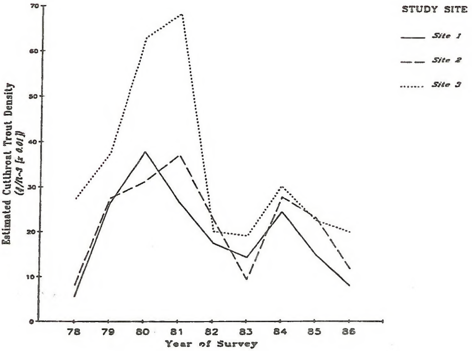
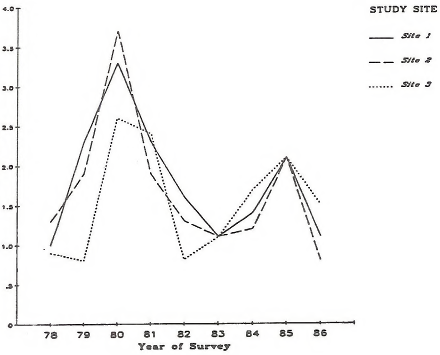


Figure 4.9. Annual Fluctuations in estimated cutthroat trout biomass (a) and density (b) expressed as weight and number, respectively, per unit volume, Gance Creek, Nevada, 1978-1986.

a.



b.

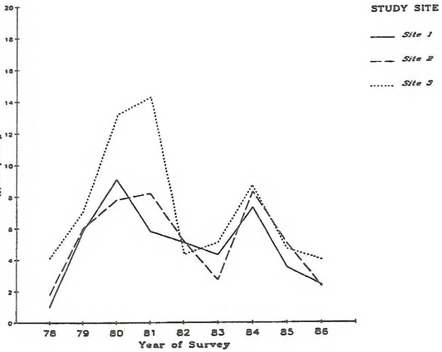


Figure 4.10. Annual Fluctuations in estimated cutthroat trout biomass (a) and density (b) expressed as weight and number, respectively, per unit surface area, Gance Creek, Nevada, 1978-1986.

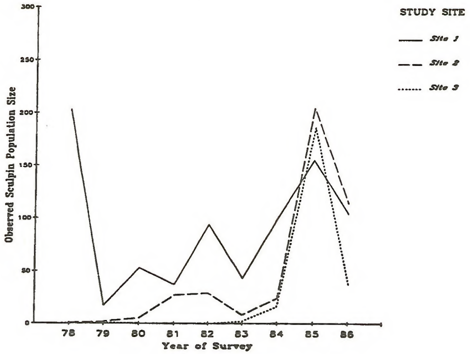


Figure 4.11. Annual fluctuations in observed sculpin numbers, Gance Creek, Nevada, 1978-1986.

variability is more likely the norm than the exception. Confusion resulting from this variability, together with unquantified and uncontrollable watershed-wide conditions have unfortunately conspired throughout the study to make any conclusions more speculative than definitive. Consequently, we offer the following conclusions tentatively, though we feel we have sufficient grounds to present them for consideration.

Clearly, Gance Creek is capable of supporting a viable cutthroat trout population. Although variable from year to year, trout were abundant and generally quite robust. There was some suggestion that deterministic or density-dependent factors were involved in the annual fluctuations in trout population size because of the parallel but lagging fluctuations in average condition factors. Of course, population size alone does not adequately describe the dynamics of the populations, some of which was further revealed by examining the biomass supported in each site. During 1981 and 1982, for example, population size and density was much higher in site 3 than in the other two sites, but biomass was remarkably similar in all three sites. This provides some evidence for the importance of stochastic or density-independent mechanisms at least limiting the actual biomass that the different portions of the stream could support. What habitat features are precisely responsible for this stochastic limitation are still uncertain.

Overall, site 1, a grazed control site, contained the best water column conditions with respect to those generally accepted to be preferred by trout: highest long-term average P:R, lowest long-term average W:D, and highest pool quality. This was reflected, in turn, by the highest average trout biomass and a relatively greater proportion of larger fish (i.e., higher long-term average mean weight and biomass at lower average density). Site 3, the other grazed control site, had generally poorer water column conditions, as well as

generally poorer streambank conditions (i.e., higher long-term average bank angle and smaller long-term average undercuts and streamshore depths). This control site, however, typically supported the highest trout densities and appeared to concentrate YOY trout. This tendency to concentrate smaller fish has apparently been waning, however, perhaps as a result of some changes in habitat conditions that favor larger individuals.

Site 2, the ungrazed treatment site was generally superior, on average, with respect to streambank conditions (i.e., lowest long-term average bank angle and highest long-term average streambank undercut) than either control site, and was generally intermediate with respect to water column conditions. This site also tended to support intermediate numbers of trout, apparently composed of a larger proportion of large fish than site 1 and a larger proportion of YOY than site 3.

Although gravel and rubble comprised the major portion of the streambottom sediments in all of the study sites, the level of fines was generally not optimal for trout. Total fine sediments averaged (long-term) less than 10% only in site 2, and frequently exceeded that level. This 10% fines composition has been reported to be the optimal for production of the benthic invertebrates used by trout for food (Hickman and Raleigh 1982). Fine sediments do not seem to be increasing over time, but neither are they declining in abundance, and embeddedness was consistently quite high in all three sites. Improving substrate conditions would appear to be one potential avenue for increasing fishery potential.

Although non-game fish, particularly sculpin, have typically comprised a significant portion of the fish community on Gance Creek, they show no obvious signs of negatively influencing the trout population. There is little convincing evidence in the literature that sculpin are serious predators of trout eggs or fry, but there is evidence that they provide as much or more prey themselves than they consume as predators (Brynildson and Brynildson 1978; Dineen 1951; Koster 1937). If they should prove to be detrimental, it seems more likely that they may be a potentially serious competitor for invertebrate food organisms with YOY trout if sculpin numbers increase greatly. At current population levels this seems not be a likelihood, but could conceivably occur if substrate conditions deteriorate so as to retard trout reproduction and invertebrate production.

Although grazing use has generally been near 50%, a level normally considered to promote rangeland maintenance, well over 70% use of riparian forage has been sustained in the more heavily grazed site 1. This heavy use has not benefited riparian conditions, either structurally or vegetally. Although it is difficult at this time to detect improving tends in the ungrazed site 2 with any certainty, temporary apparent improvement in riparian conditions of the grazed control sites can be seen in years with reduced grazing intensity. In site 1 in 1986, for example, bank stability and cover ratings improved over 1985 levels, while grazing intensity was 32% lower. High runoff and remote watershed conditions that promote streambank abrasion and channel scouring surely aggravate the situation in the control sites and retard rehabilitation in the ungrazed site, but it seem clear to us that some slight improvement can be detected in the ungrazed site and in the control sites when grazing use is low. Additional riparian rehabilitation would probably occur at an increasingly rapid rate as increased cover and stability begin to protect the banks from high spring flows (see also Platts et al. 1985).

References

Bailey, J.E. 1952. Life history and ecology of the sculpin Cottus bairdi punctualtus in southwestern Montana. Copeia. 1952(4):243-255.

Brynildson, O.M., and C.L. Brynildson. 1978. Distribution and density of sculpins in a Wisconsin coulee stream. Wisc. Dept. Nat. Res., Res. Rep. 98. Madison, WI. 5p.

Dineen, C.F. 1951. A comparative study of the food habits of Cottus bairdi and associated species of Salmonidae. Amer. Midl. Nat. 46(3):640-645.

Hickman, T., and R.F. Raleigh. 1982. Habitat suitability index models: cutthroat trout. USDI Fish and Wild. Serv. FWS/OBS-82-10.5. 38p.

Koster, W.J. 1937. The food of sculpins (Cottidae) in central New York. Trans Amer. Fish. Soc. 66:374-382.

Platts, W.S., C. Armour, G.D. Booth, M. Bryant, J.L. Bufford, P. Cuplin, S. Jensen, G.W. Lienkaemper, G.W. Minshall, S. Monsen, R.L. Nelson, J.R. Sedell, and J.S. Tuhy. 1987. Methods for evaluating riparian habitats with applications to management. USDA For. Serv. Gen. Tech. Rep. INT-221. Intermt. For. and Range Exp. Stn., Ogden, UT. 177p.

Platts, W.S., K.A. Gebhardt, and W.L. Jackson. 1985. The effects of large storm events on basin-range riparian and stream habitats. North Amer. Riparian Conf., Tucson, AZ. April 16-18, 1985. p. 30-34.

Platts, W.S., W.F. Megahan, G.W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. USDS For. Ser. Gen. Tech. Rep. INT-138, Intermt. For. and Range Exp. Stn., Ogden, UT. 70 p.

Platts, W.S. and R.L. Nelson. (In prep.) Stream canopy and its relationship to salmonid biomass in the Intermountain west. Proposed for publication in the North American Journal of Fisheries Management.

Platts, W.S. and R.L. Nelson. 1983a. Livestock-fishery interaction studies, Gance Creek, Nevada. Progress Report 5. Unpubl. report on file, USDA For. Serv., Intermt. For. and Range Exp. Stn., For. Sci. Lab., Boise, ID. 139p.

Platts, W.S., and R.L. Nelson. 1983b. Population fluctuations and genetic differentiation in the Humboldt cutthroat trout of Gance Creek, Nevada. Cal-Neva Wildl. Trans. 1983:15-19.

CHAPTER 5

A STUDY OF FACTORS INFLUENCING SECONDARY SUCCESSION

Richard E. Eckert, Jr. and Fay L. Emmerich

Secondary succession depends on the periodic recruitment, by natural revegetation, of new plants of desirable species to replace plants of less desirable species. This can be a very slow process in arid or semiarid environments because weeds are not controlled, a seedbed is not prepared, seed quantity and quality are generally low, seed is not planted, and date of seeding is not optimum.

Land management agencies presently are monitoring trends in range condition and interpreting these trends based on management objectives. These objectives define the change in composition of key species that should occur for a given plant community in response to particular management strategies. If the probability of achieving these objectives is very low, one could confuse the improbability of a biological response to management with general fault of the management strategy. Understanding the reasons for, and the rate of, secondary succession is essential for the realistic statement of management objectives and for the accurate interpretation of vegetation change. Such understanding can be used by land managers to: 1) identify soil limitations and potentials, 2) predict change in species composition, 3) determine why changes in species composition occurred or did not occur as predicted, 4) aid in the interpretation of changes in species composition due to grazing or other perturbations, and 5) extrapolate interpretations to similar ecological sites.

Rather than studying vegetation change over time, perhaps secondary succession could be simulated through modeling techniques. Development of a model for secondary succession requires knowledge about the functions of various factors influencing the establishment of perennial plants. Some of these factors are quantity and quality of seed of desirable, less desirable, and undesirable species; and the effects of level of competition, kind and amount of different soil surfaces, and amount and timing of precipitation on germination, emergence, and establishment requirements of these species. This study evaluates the interactions between precipitation regimes and these factors and their effect on secondary succession in the sagebrush type.

Previous natural population and seeding studies have shown that some plant establishment occurred in competitive situations on certain soil-surface types and microsites. Most established plants were of exotic or increaser species such as crested wheatgrass, cheatgrass, sagebrush, squirreltail, and Sandberg bluegrass. The question arises, what mechanism is responsible for the periodic establishment of decreaser grasses? Some researchers have suggested that natural establishment of native species in harsh environments occurs only in years of unusually high precipitation. Episodic precipitation events of low probability and resulting increases in the amount and longevity of available soil water may be the principal mechanism by which the depressing effects of environmental stress are mitigated enough to allow secondary succession to advance. By identifying species response to periods of favorable soil water and to drought conditions, the land manager could use precipitation probabilities to more precisely state management objectives and

to interpret reasons for recruitment or lack of recruitment of new plants of desirable species.

A 3-year study is underway to evaluate emergence and establishment of exotic and native increaser and decreaser grasses in response to precipitation probability treatments applied to coppice and interspace soil surfaces in cleared and brush areas. These two surfaces were selected because they are the most abundant between shrubs and because they are the surfaces on which secondary succession will most likely occur. Results from 1986 represent the second year of the study.

1986 Objectives:

1. Continue research on the influence of sagebrush competition, soil-surface type, and precipitation probability on emergence and establishment of native and introduced grasses.

Methods. The study was conducted on three range sites: Loamy 8-10", Loamy 10-12", and Claypan 10-12". All shrubs were removed from two sets of plots in late July 1985. A seeding was made in early October 1985 to evaluate seedling survival and plant establishment from spring 1986-emerged seedlings. In each replication of each brush treatment, four, 1-ft^2 plots were randomly located on coppice soil and four plots were located on interspace soil. Each plot was subdivided into four randomly selected 0.25-ft^2 subplots, and seed of crested wheatgrass, bluebunch wheatgrass, bottlebrush squirreltail, and Thurber needlegrass was broadcast on the soil surface and mixed with the surface half inch of soil.

Four precipitation-probability treatments were randomized on the soil-surface plots. These were: natural precipitation falling from May to the end of September, 1986; 50% probability - simulated precipitation equal to 50% probability of a weekly amount of precipitation from May to the end of September, 25% probability and 5% probability. The amounts of precipitation applied by these treatments for months representing the spring 1986-emergence study are shown in Table 5.1. Simulated-precipitation treatments were applied weekly. A measured amount of water was sprinkled over a plot frame that minimized movement of surface water among subplots and from the inside of the plot to the outside of the plot. Experimental design within each brush treatment was a 2x4x4 factorial with six replications. Gypsum blocks were buried at depths of 1,2, 3 and 4 inches in two of the six replications before seeding. Soil-water data were collected immediately before watering and at intervals of 1,2,3 and 4 days after watering. Meter readings were converted to bars of soil-water tension. Seedlings were counted in May, June, July, and August. Seedling-density data for each brush treatment were analyzed by a 3-factor analysis of variance to determine treatment effects and interaction averaged over dates, species, and soil-surface types with significant ($P \leq 0.05$) means determined by Duncan's multiple range test.

Results of spring 1985 emergence were presented in the 1985 Saval Progress Report. In spring 1986 a sample of plants from the 1985 study were selected to receive the 5% precipitation-probability treatment through the second growing season in order to evaluate the effects of additional water on plant establishment.

Table 5.1. Total of natural and simulated precipitation (in.) on each precipitation treatment for spring 1986-emerged seedlings on three ecological sites.

Site and precipitation treatment	1985-86	May	June	July	Aug	Sept[2]	Total
Loamy 8-10"							
Natural, Oct-May	10.0						
Natural, by month		0.6	0.4	1.1	0.1	0.3	2.5
50% probability		0.8	0.4	1.1	0.1	0.3	2.7
25% probability		1.3	0.6	1.5	0.4	0.5	4.3
5% probability		2.4	2.4	3.1	1.6	1.7	11.2
Loamy 10-12"							
Natural, Oct-May	11.9						
Natural, by month		0.3	0.6	1.0	0.1	0.2	2.2
50% probability		0.6	0.6	1.0	0.2	0.2	2.6
25% probability		1.2	0.8	1.5	0.5	0.5	4.5
5% probability		2.6	3.4	3.7	2.1	2.3	14.1
Claypan 10-12"							
Natural, Oct-May	9.6						
Natural, by month		0.3	0.4	0.8	0.0	0.3	1.8
50% probability		0.5	0.4	0.8	0.1	0.3	2.1
25% probability		1.1	0.9	1.2	0.3	0.5	4.0
5% probability		2.3	3.2	3.1	1.7	1.9	12.2

[1] from week of 5/19
[2] through week of 9/22

Results

Density and Height of Plants Surviving from Spring 1985-Emergence.

Spring 1986. Plants present in spring 1986 from fall 1984 seeding (Table 5.2) represent 1-year old individuals that survived one growing season and one winter. Plant density followed the same trend as that in October 1985 on both brush and cleared areas, i.e., crested wheatgrass had the greatest number of plants in most comparisons and was equal to Thurber needlegrass in some comparisons, Thurber needlegrass generally was second ranked, and generally more plants of crested wheatgrass and Thurber needlegrass occurred on coppice soil than on interspace soil. Generally more crested wheatgrass and Thurber needlegrass plants were present on the 5 and 25% precipitation treatments on coppice soil than on the natural and 50% treatments on the coppice or interspace soil. In October 1985, simulated-precipitation treatments were significant in only two of six comparisons. In spring 1986, however, precipitation treatments were significant in five of six comparisons. This response suggests that additional soil water during the previous growing season was important to future survival of plants on the harsher sites and treatments.

Density of surviving plants in spring 1986 was similar on brush and cleared areas. However, plants in the brush area on all sites resembled large seedlings with a single culm while plants on cleared areas had multiple culms that formed small bunches with a basal diameter of up to 1 in.

Fall 1986. Plants present in fall 1986 (Table 5.3) represent survival at the end of the second growing season. These data are means of the unwatered and watered treatments that were continued during the second growing season because watering treatments were not significantly different in any comparison. This response suggests that additional water during the second growing season was not important to the establishment of 2-year old plants. Plant density continued to be higher on coppice soil than on interspace soil on both the brush and clear areas of the Loamy 8-10" and Claypan 10-12" sites. Plant densities on the two soil-surface types were similar on the Loamy 10-12" site where coppice and interspace soils are more similar. Both these trends were evident throughout the study. Plant density on the Loamy 8-10" site for coppice and interspace soils was 1.8 and 0.5/0.25 ft^2, respectively; for the Claypan 10-12" site, 1.6 and 0.3/0.25 ft^2. Crested wheatgrass had the highest survival on the Loamy 8-10" site, Thurber needlegrass density was highest on the Loamy 10-12" site, and both species had similar densities on the Claypan 10-12" site (Table 5.3).

Densities of established 2-year old plants of most species in fall 1986 would appear to be more than adequate for secondary succession. However, two points need to be emphasized. 1) Seed was mixed with the surface soil and therefore was placed in intimate contact with the soil where germination conditions would be optimum. Under natural conditions, germination would have to occur from seeds lying exposed on the soil surface - a very unfavorable environment. 2) Seed rain under natural conditions on nearby sites (Table 5.4) was much lower than the 100 viable seeds planted. Seed reservoir in the soil from seed rain would be from 1/4 to 1/100 of the seeding rate used. Seed rain was also calculated for a big sagebrush-Thurber needlegrass ecological site in different range condition (Table 5.5). Even on high condition sites,

Table 5.2. Mean density/0.25 ft^2 in May 1986 of 1-year old plants of four species on the brush area of two ecological sites in response to natural precipitation and to precipitation-probability treatments. Plots were planted in October 1984 with 100 viable seeds. Seedlings emerged in spring 1985.

	Loamy 8-10"				Claypan 10-12"			
	---------Probability (%)---------				-----------Probability (%)-----------			
Species	Natural	50	25	5	Natural	50	25	5
Crested wheatgrass	1.2 cd[1]	0.8 d	3.9 b	6.0 a	0.1 b	0.1 b	1.8 a	1.3 a
Bluebunch wheatgrass	0.2 d	0.1 d	0.2 d	0.8 d	0.0 b	0.0 b	0.0 b	0.0 b
Squirreltail	0.1 d	0.0 d	0.0 d	0.1 d	0.0 b	0.0 b	0.0 b	0.0 b
Thurber needlegrass	1.5 cd	0.5 d	0.4 d	2.2 c	0.0 b	0.2 b	1.8 a	1.2 a

[1]Means in columns and rows for each ecological site followed by the same letter are not significantly different ($P \leq 0.05$).

Table 5.3. Mean density/0.25 ft^2 of plants of four species in October 1986 after two growing seasons on the brush area of three ecological sites. Plots were planted in October 1984 with 100 viable seeds. Seedlings emerged in spring 1985.

Species	Loamy 8-10"	Loamy 10-12"	Claypan 10-12"
Crested wheatgrass	3.5 a[1]	1.3 b	1.8 a
Bluebunch wheatgrass	0.3 bc	0.3 c	0.5 b
Squirreltail	0.0 c	0.3 c	0.0 b
Thurber needlegrass	0.9 b	2.4 a	1.5 a

[1]Means within each ecological site followed by the same letter and are not significantly different ($P \leq 0.05$).

Table 5.4. Mean number of viable seeds/0.25 ft^2 of crested wheatgrass and of native species in 3 years.[1]

Species	1983	1984	1985
Crested wheatgrass	25	6	12
Bluebunch wheatgrass	2	2	1
Squirreltail	10	2	2
Thurber needlegrass	<1	<1	<1

[1]Seed density was calculated from seed yield, weight/100 seeds, and percent germination.

Table 5.5. Relation between ecological-range condition and estimated seed rain of Thurber needlegrass (no./0.25 ft^2).[1]

Condition	1974	1975	1976	1977	1978	1979
Potential Natural Community	80	115	0	8	30	0
Late-seral	49	70	0	5	20	0
Mid-seral	18	26	0	2	7	0
Early-seral	1	2	0	<1	<1	0

[1] Calculated from basal area of Thurber needlegrass on sites in different condition, seed yield/in^2 of basal area, and percent germination.

little or no seed is produced in some years. Seed is not necessary for secondary succession on sites in late-seral and higher range condition because plant density is already sufficient for high production. Seed production is much less on sites in early-seral and mid-seral condition and is about 1/4 to 1/100 of the seeding rate used in the study. The low seed rain in both of these examples greatly exacerbates the low reproduction of native species obtained from the 100 viable seeds planted in the study.

Plants surviving until October 1986 on all sites, most brush treatments, both soil-surface types, and all simulated precipitation treatments were similar in size. Although some plants on both brush treatments on the Loamy 8-10" and Loamy 10-12" sites resembled large, single-culmed seedlings, most crested wheatgrass plants were up to 7 in. tall; bluebunch wheatgrass up to 5 in., and Thurber needlegrass up to 4 in. These plants had multiple culms and were in distinct bunches. On the Claypan 10-12" site, plants of all species did not exceed 2 in. on the brush area. On the cleared area, however, plants were similar in size to those on the other sites. The cleared areas of the Loamy 8-10" and Claypan 10-12" sites were the only situations in which crested wheatgrass alone produced reproductive culms up to 14 in. high.

Density of Spring 1986 - Emerged Seedlings

October 1985 to May 1986 precipitation was 10.0 in. on the Loamy 8-10" site, 11.9 in. on the Loamy 10-12" site, and 9.6 in. on the Claypan 10-12" site. Winter-spring and April-May precipitation was one third to one-half greater in 1986 than in 1985. Seedling densities in early May 1986 (Table 5.6) represent a response to coppice and interspace soil surfaces only because simulated-precipitation treatments were not initiated until mid-May. Subsequent data represent plant response to soil-surface type, brush competition, and simulated-precipitation treatments. Data in Table 5.6 show no significant differences because the species x soil interaction was not significant. However, the soil x species interaction was significant in August as shown in Tables 5.7.

Densities in early May generally were similar to those obtained in May 1985. The main difference was that in 1986 generally more seedlings emerged on interspace soil than on coppice soil on the Loamy 10-12" and Claypan 10-12" sites. However, on the Loamy 8-10" site, seedling density generally was greater on coppice soil. A possible explanation for this result is that precipitation on the driest site (Loamy 8-10") was not sufficient to maintain a moist interspace surface and seedling emergence was restricted. On the more moist Loamy 10-12" and Claypan 10-12" sites, precipitation was adequate to maintain a moist interspace surface. Past research has shown that the moist surface of interspace soil does not inhibit seedling emergence. Apparently a moist interspace surface was more favorable for seedling emergence than was the more loose and fluffy seedbed provided by the coppice surface.

For seedlings surviving the first growing season, plant densities on the Loamy 10-12" and Claypan 10-12" sites were generally greater on the coppice soil than on the interspace soil (Table 5.7). Also, density of crested wheatgrass on the brush and non-brush areas of the Loamy 8-10" site was greater than for Thurber needlegrass (Table 5.8). On the Loamy 10-12" site, density of Thurber needlegrass was greater than that of crested wheatgrass on the brush area and density of the two species was similar on the cleared area. On the Claypan

Table 5.6. Mean seedling density/0.25 ft^2 on coppice and interspace soils on three ecological sites with shrub cover for the first sample date in 1986 (May). Plots were planted with 100 viable seeds in October 1985.

	Loamy 8-10"		Loamy 10-12"		Claypan 10-12"	
Species	Coppice	Interspace	Coppice	Interspace	Coppice	Interspace
Crested wheatgrass	10.5	8.5	5.8	7.3	6.9	8.9
Bluebunch wheatgrass	1.4	0.5	1.1	3.3	1.6	2.4
Squirreltail	1.3	1.4	1.2	3.2	1.4	2.8
Thurber needlegrass	5.6	3.4	5.4	6.4	4.2	4.7

Table 5.7. Mean seedling density/0.25 ft^2 in August 1986 of four species on coppice (C) and interspace (I) surface soils on three ecological sites with and without brush competition. Plots were seeded with 100 viable seeds in October 1985. Seedlings emerged in spring 1986.

	Crested wheatgrass		Bluebunch wheatgrass		Squirreltail		Thurber needlegrass	
Competition level	C	I	C	I	C	I	C	I
				Loamy 8-10"				
With brush	8.1a[1]	6.6b	0.8a	0.4b	0.6a	0.7a	4.3a	2.4b
Without brush	4.1b	7.7a	0.5a	0.6b	0.8a	0.5b	2.5a	2.8a
				Loamy 10-12"				
With brush	3.7a	4.1a	0.7b	1.4a	0.6b	1.6a	3.7b	4.6a
Without brush	3.0b	5.8a	0.3b	0.8a	0.8b	2.0a	2.5b	3.5a
				Claypan 10-12"				
With brush	4.6b	6.1a	0.9b	1.5a	0.7b	1.1a	3.6a	3.8a
Without brush	6.1b	7.6a	1.0a	1.2a	1.3a	1.1a	7.4a	5.5b

[1]Means for each species on coppice or interspace soil surfaces within a brush treatment of each ecological site followed by the same letter are not significantly different ($P \leq 0.05$).

Table 5.8. Mean seedling density/0.25 ft^2 of four species in August 1986 on three ecological sites with and without brush competition. Plots were seeded with 100 viable seeds in October 1985. Seedlings emerged in spring 1986.

Competition level	Crested wheatgrass	Bluebunch wheatgrass	Squirreltail	Thurber needlegrass
		Loamy 8-10"		
With brush	5.0a[1]	0.3c	0.2c	2.4b
Without brush	4.2a	0.4c	0.4c	2.0b
		Loamy 10-12"		
With brush	1.3b	0.3c	0.2c	2.4a
Without brush	2.6a	0.4c	0.8b	2.1a
		Claypan 10-12"		
With brush	2.8a	0.6b	0.1b	2.7a
Without brush	5.2a	0.8b	0.6b	5.4a

[1]Means for each species within a brush treatment of each ecological site followed by the same letter are not significantly different ($P \leq 0.05$).

site, densities of the two species were similar on both brush treatments. Densities of bluebunch wheatgrass and squirreltail were similar, very low, and significantly less than for crested wheatgrass and Thurber needlegrass. Densities of surviving seedlings of crested wheatgrass, bluebunch wheatgrass, and Thurber needlegrass in August 1986 were 44, 17, and 44%, respectively, of densities of surviving seedlings in August 1985. This result suggests that seedling mortality during the first growing season was greater in 1986 than in 1985. Densities of squirreltail seedlings in both years were too small to make such a comparison.

Seedling densities of all species on both brush treatments were generally highest on the first, or first and second, sampling dates then declined significantly in the third and fourth sampling periods. An example of this response is presented for crested wheatgrass and Thurber needlegrass on the Loamy 10-12" site (Tables 5.9 and 5.10).

On all sites where precipitation-probability treatments were significant, generally more crested wheatgrass, squirreltail, and Thurber needlegrass plants were found on the 5 and 25% treatments than on the 50% or natural precipitation treatments. An example of this response for crested wheatgrass and Thurber needlegrass is shown for the Loamy 10-12" site (Tables 5.9 and 5.10).

Soil-moisture regime for spring 1986-emerged seedlings

Soil at all sites was wet (-0.1 to -2 bars) to a depth of 18 in. in mid May. Available water (-0.1 to -15 bars) was depleted at 6 in. by May 28 to June 18, at 12 in. by June 5 to 26, and at 15 in. by June 12 to 26. Therefore, most of the water available to seedlings after these dates was that supplied by the simulated-precipitation treatments.

Natural precipitation influenced soil-water tensions only during one period in spring, summer, or fall. About 1 in. of rain fell on July 24 and 25. Soil-water tensions at various depths remained below -15 bars from 5 to 13 days on the Loamy 8-10" site, from 5 to 11 days on the Loamy 10-12" site, and from 4 to 6 days on the Claypan 10-12" site. The shorter periods of moist soil occurred at the 1- and 2-in. depths and the longer periods occurred at the 4- and 6-in. depths.

Before and after this rainfall event,the 50% probability treatment did not influence soil-water tensions at 1 and 2 in. after May 20 and never did influence tensions at 4 and 6 in. The 25% probability treatment did not influence soil-water tensions at 1 and 2 in. after the end of May and had no influence at any time at 4 and 6 in. Before the end of May, soil-water tensions at 1 and 2 in. were below -15 bars for 2 to 4 days/week. The 5% treatment influenced soil-water tensions at 1 and 2 in. most of the growing season, but had little effect at 4 and 6 in. From early May to mid August and in late September, the 5% treatment resulted in tensions below -15 bars for 2 to 3 days/week. From mid August to mid September this treatment did not influence tensions. Both the 5 and 25% probability resulted in the same pattern of increasing and decreasing soil water tensions. Tensions at 2 in. remained lower than at 1 in. for a day or so longer each week except during the hot part of the summer when the small amounts of water applied did not percolate to 2 in.

Table 5.9. Mean seedling density/0.25 ft^2 of crested wheatgrass on a Loamy 10-12" ecological site in response to date of sample and simulated precipitation main effects with and without brush competition. Plots were seeded with 100 viable seeds in October 1985. Seedlings emerged in spring 1986.

	Date of sampling			
Competition level	5/8	6/19	7/16	8/13
With brush	6.6a	5.1b	2.8c	1.3d
Without brush	6.1a	5.0ab	3.9b	2.6c
	Simulated precipitation (% probability)			
	Natural	50	25	5
With brush	3.4	4.1	4.2	4.0
Without brush	3.5b	3.7b	3.8b	6.4a

[1]Means within each brush treatment of each main effect followed by the same letter are not significantly different ($P \leq 0.05$).

Table 5.10. Mean seedling density/0.25 ft^2 of Thurber needlegrass on a Loamy 10-12" ecological site in response to date of sample and simulated precipitation main effects with and without brush competition. Plots were seeded with 100 viable seeds in October 1985. Seedlings emerged in spring 1986.

	Date of sampling			
Competition level	5/8	6/19	7/16	8/13
With brush	5.9a	5.0a	3.5b	2.4b
Without brush	4.0a	3.3ab	2.6bc	2.1c
	Simulated precipitation (% probability)			
	Natural	50	25	5
With brush	3.9bc	2.7c	4.8ab	5.3a
Without brush	2.4c	2.6bc	3.3ab	3.7a

[1]Means within each brush treatment of each main effect followed by the same letter are not significantly different ($P \leq 0.05$).

Over-winter and second-year survival of spring 1986-emerged seedlings will be determined in 1987. In addition, emergence and first-year survival of spring 1987-emerged seedling will be determined. Simulated precipitation treatments will be applied to spring 1987-emerged seedlings and plant density and height and soil water data will be collected. After the last sample in September, data for all three years will be summarized and a publication prepared.

CHAPTER 6

VEGETATION TREND AND UTILIZATION MONITORING STUDY

Paul T. Tueller and Jay M. Hinshaw

Work on the project was initiated in May, 1986. The Saval Allotments were examined by both the principal investigator and the graduate student in company with the Saval Project Manager and representative range conservationists from the U.S. Forest Service and the Bureau of Land Management. The Forest Service and BLM were responsible for developing a monitoring program for their allotments without any discussion or input from the researchers. The plan prepared by the agencies consisted of 3 long-term frequency macroplots on the Forest Allotment and 5 long-term frequency macroplots on the BLM administered lands. An agreement was made that both agencies would also compile annual use maps for short-term monitoring.

The allotments were further examined by the researchers and stratified into 11 major plant communities which in all but one case correspond with previously published Soil Conservation Service ecologic range site descriptions. Thirty-two frequency macroplots were selected for long-term monitoring primarily from the existing Saval Project data base. Most were sampled in 1979 or 1980 than resampled in 1984 or 1985. Copies of the raw data were acquired through the BLM computer in Denver and have been statistically analyzed to determine changes in vegetation trend on the selected macroplots. This data will serve as a "redundant" sample for the determination of required sample sizes for adequate monitoring.

In preparation for using the Key Forage Plant Method (KFPM) of determining utilization, the following key forage species were sampled at three different elevational categories in order to develop height-weight charts and provide better estimates of forage use: *Agropyron spicatum*, *Festuca idahoensis*, *Elymus cinereus*, *Balsamorhiza saqittata*, *Agropyron cristatum*, and *Sitanion hystrix*. Clipping and weight determinations were done at 3, 5, and 10 cm increments depending on average species height. Height-weight curves for these species have been hand-drafted but are not yet available in a computer-graph form. Six additional key forage species were identified by the researchers in 1986, which will be sampled in the same manner during the 1987 field season. It is hypothesized that agencies may need to develop height-weight curves for their own key forage species for more accurate monitoring in the future.

After cattle were removed from the pastures, approximately 175 Key Forage Plant (KFP) Write-ups were done in conjunction with livestock fecal count transects to estimate utilization. Using six use categories, general use maps of the pastures were compiled from field notes taken during the same time. A student cartographer, at the University of Nevada-Reno, has recently completed the final draft of Jay Hinshaw's 1986 Saval General Use Map with a mylar overlay of the KFPM estimations of utilization. This allows for a comparison between the two methods to help meet the goal of developing guidelines for combining the KFPM with general use mapping.

In addition, twenty 4 feet by 4 feet utilization cages were placed on five different SCS ecologic range sites on the Forest Allotment before the grazing season. After cattle had grazed the allotment, the vegetation inside and outside the cages was sampled after completing KFPM write-ups for the areas. This has allowed for a comparison of actual use estimations to KFPM estimations of utilization to test the relative accuracy of the latter method. Utilization cages will be placed on five SCS ecologic range sites on BLM land in the 1987 field season.

Three major problems were encountered: First, 1986 grazing use was not what was prescribed in the agencies' Allotment Management Plans. Yearlings rather than cow-calf pairs were placed on the allotments about 2 months later than normal. Secondly, neither the BLM nor the Forest Service fulfilled their agreement to compile annual use maps. Finally, after the official foreclosure of the Saval Ranch, FHA announced their intention to rest the entire ranch during the 1987 grazing season.

In order to gather utilization data this coming field season, we have made agreements with area ranchers, Charlie Van Norman and Pete and Sam Mori, to monitor their allotments. The BLM and Forest Service range conservationists plan to monitor these areas also and are cooperating in the effort to make this project a success.

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